PHILIPPINE
JOURNAL
OF
SCIENCE

57
MAY-AUG
1935

THE PHILIPPINE JOURNAL OF SCIENCE

VOLUME 57

MAY TO AUGUST, 1935
WITH 48 PLATES AND 29 TEXT FIGURES

MANILA
BUREAU OF PRINTING
1935

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

CONTENTS

No. 1, May, 1935

[Issued July 13, 1935.]

No. 2, June, 1935

[Issued August 21, 1935.]

No. 3, July, 1935

[Issued August 23, 1935.]

No. 4, August, 1935

[Issued October 5, 1935.]

VOL. 57, No. 1 MAY, 1935

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VOL. 57 MAY, 1935 No. 1

GINKGO ADIANTOIDES (UNGER) HEER; CONTEMPORARY AND FOSSIL FORMS

By K. SHAPARENKO

Of the Botanical Institute, Academy of Sciences, Leningrad

ONE PLATE AND EIGHT TEXT FIGURES

While studying the palæobotanic specimens of the Leningrad Section of the Research Oil Institute to identify the plant impressions collected by Geologist P. K. Ivanchuk in Miocene deposits near the village Krymskaya in the northern Caucasus, I found what I thought was a ginkgo. On further study I met with various contradictory opinions, of diverse authors, as to the specific Tertiary and Cretaceous peculiarities of this genus.

In past geologic epochs ginkgoes developed and spread rapidly over the world. Their earliest representatives are found in the Middle Devonian.[1] They attained their greatest development during the Mesozoic era, especially in the Jurassic period. No precise picture can be given of the evolution of the group in different geologic periods. The leaves, upon which the classification of ginkgoes is based, have no connection with generative organs and do not give us sufficient data. The Jurassic was the culminating period of the ginkgoes. In Cretaceous deposits they were mostly localized, filled small areas, and were less numerous than in the preceding period.

[1] *Psygmophyllum Kolderupii* Nathorst, from the Middle and the Upper Devonian in Norway, and *P. Kiltorkense* Johnson in Ireland [Kräusel (1926) and Zimmerman (1930)]. More recently some authors referred these species to the ferns, which demonstrates the fundamental difficulties of the systemization of ginkgoes in our study of these plants. In some cases it is scarcely possible to distinguish the leaves of the ginkgo from those of the fern.

From that time to the present there has been a continuous regression. The only living representative of this group is *Ginkgo biloba* Linnæus, which was first known only in cultivation, as a sacred tree in the gardens of some Japanese temples; at the beginning of the eighteenth century it was brought to European and North American botanic gardens.

Whether or not the tree has been preserved anywhere in a wild state is not yet clear. Seward and Gowan,(64, p. 109) according to the notes of travellers, quoted it for the forests that surround the sources of Gold River and the smaller Min in western China, and Lebunge Valley in southwestern China; but Pilger,(60) taking into consideration Wilson's descriptive notes,(80) considers this to be a misunderstanding due to confusion of Chinese names. That it is the sole living representative of what once was a vast group, makes the study of forms related to *Ginkgo biloba* interesting, and may shed light on its origin and determine the character and immediate causes of its regression.

In 1850 Unger described *Salisburia adiantoides,* a fossil species nearest to *Ginkgo biloba* Linnæus. For a time some authors used the generic name *Salisburia,* and others *Ginkgo.* The names are certainly synonymous.

This confusion of the names of fossil representatives has been caused by a similar misunderstanding with regard to the living representative, which was first described by Kaempfer,(27) under the name "Ginkgo." Linnæus(53) included it in his Mantissa plantarum (1771). In 1797 Smith found the name of the species "incorrect" and the generic name "uncouth," and changed the name of the plant to "*Salisburia adiantifolia.*" For some time the latter incorrect name was used by botanists and also by Heer. Later Heer himself gave the species the correct name.

Heer,(13, p. 183; 14, p. 465) Pilar,(59, p. 23) Gardner,(10) and several other modern authors note the probable identity of *Ginkgo adiantoides* with the present species. However, they do not advance this opinion in a categorical form, partly for want of knowledge of its generative organs, partly owing to considerations of principle.

As it is, the classification of ginkgoes, based on the form and the lobulation of the lamina, is highly artificial, and in the modern species we find that these characters are subject to

many variations. The shape of the leaf of *G. biloba* differs according to its ecologic condition, the age of the tree, and its garden forms. Even in a single tree the shape of ginkgo leaves changes according to the age of the specimen, the position of the branch, and the position of the leaf on the branch.

We may cite the opinion of Seward and Gowan (64, p. 120) on this matter, as follows: ". . . a striking feature of Ginkgo-leaves is the variation in their size and shape, a fact insufficiently recognized by paleobotanical writers." In one of his latest works Seward (66) writes, on his observations of a series of leaves, on different branches and in different seasons, that it is unprofitable to utilize as characters of species lobulation or size of the lamina.

Elwes and Henry (8) are almost of the same opinion, describing garden forms of *G. biloba* Linnæus, many of which may be distinguished by the form of their leaves. They speak of lobulation as a character "scarce worthy of recognition," because leaves of all ginkgo trees possess variable lobulation.

Salfield (69) attaches no systematic importance to the lobe-shaped leaf of *Ginkgo biloba* Linnæus, and takes it as evidence of a diseased condition. Kräusel (39) holds another opinion; he refutes the possibility of disease being the cause of differentiated lobulæ and considers it possible that *G. biloba* owes this dissimilar form to influences of soil and climate; he asserts that the genus belongs to a cultivated species. Without refuting the influence of climatic, geologic, or ecologic factors in general in the formation of a given-shaped lamina, one cannot overlook the importance of artificial selection, which without doubt existed in former periods of the earth's history; but it is scarcely possible to indicate with any degree of exactitude what were the insiduous claims demanding the special development of the lobed leaf in the maidenhair tree held to be sacred in the Far East. We are in the dark as to how the genus came to be regarded as sacred. Light may be thrown on this subject by Sinologic study, which alone could explain the many questions as yet unanswered by botanists.

It is scarcely possible to prove that the differences between the European and North American specimens of ginkgo trees are due to artificial selection, as the tree itself has not been nurtured in those latitudes for more than three hundred years. It

is more likely that China furnished different ginkgo specimens to those countries, because the "striking features" of the ginkgo leaves are not included in any of the above suppositions.

Bailey,(1) in his studies of this tree, has solved the question and suggests that these peculiarities of foliage are "fitful recol-

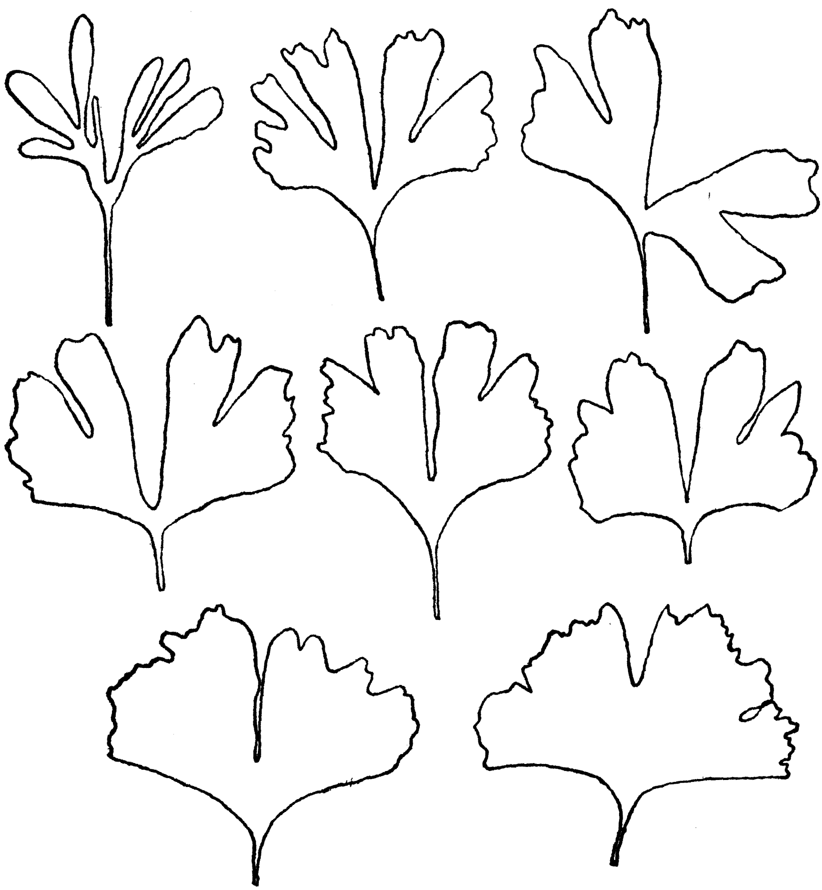

FIG. 1. Leaves of *Ginkgo biloba* Linnæus from the forest institution in Weener (Hannover). The leaves of the upper and middle rows belong to branches 1 year old; the lower row grew on older branches. [After Kräusel, Centralbl. für Mineral. (1917).]

lections of an ancient state," and Seward and Gowan(64, p. 197) also hold to the opinion that in some cases the deeply cut lamina of the leaf may be ascribed to genealogic heritage. As a proof of this statement they point to the fact that among Jurassic ginkgoes the lamina is of different shape, having narrower and more-numerous segments.

Fankhauser(9) and other authors prove that the first leaves of the seedlings of *Ginkgo biloba* Linnæus have a deeply cut lamina with a cuneiform base, and the following leaves of the plant have a more distinct lamina with a reniform base. This view is confirmed by some drawings of the leaves given us by Pilger(60, p. 98) as well as by an article of Kräusel(16) containing a few reproductions of the ginkgo leaf on branches of different ages. The leaves on the younger branches have a more elongate base with deeper sections, resembling the fossil *Baiera;* the leaves of the older branches of the tree are only slightly lobed, with a reniform base (text fig. 1).

In studying the leaves of *Ginkgo* in Adzharistan I was able to make the same observations, as may be seen in part in the accompanying photographs (Plate 1, figs. 1 to 3). A study of various species of *Ginkgo* shows that all ancient species have a more-dissected leaf, as is true of the genus *Ginkgo* on the whole in connection with the genus *Ginkgoales* of older origin; other groups prove that the segments of the lamina become narrower and filiform according to their more-ancient origin.

It is clear that the variation of the leaves of *G. biloba* Linnæus is a result of the biogenetic principle of Müller-Haeckel (ontogenesis repeats phylogenesis). There are fewer primitive characters on older specimens or shoots, and more on the younger ones. This matter has to be taken into consideration in describing the fossil ginkgo, in order to avoid confusion of the leaf with the leaves of other genera and species. A study of this species may show a higher percentage of primitive lamina forms among the impressions in older strata than in younger strata.

Chachloff(5) is of the same opinion as we are as to the evolution in the shape of the lamina of *Ginkgoales,* but explains this phenomenon in another manner. He writes: (5, pp. 17–18) "The degree of the deeply lobed lamina . . . proves that the number of the sections augments gradually from the genus Ginkgo L. to the genus Czekanowskia Hr . . . the genus Czekanowskia Hr. pertains to one phylogenetical branch Ginkgo-Baiera-Czekanowskia descendant of the genus Baiera R. Br." These deductions do not coincide with his former views on the subject and are certainly wrong, "as we know the most primitive and oldest representative of the Gingkgoales is the genus Ginkgo L., which appeared at the end of the carbon age . . . the most primitive

of the species with very slightly lobed leaf like the only genus of our day the genus Ginkgo biloba L." Evidently Chachloff has in view some of the specimens of ginkgoes of the Permian-Carboniferous period erroneously included in the genus *Ginkgo* (*G. martenensis* Ren., *G. cuneata* Schmalh., and others), as the shape of the leaves resembles that of the leaves of *Baiera.* Although Zalessky(83) called them *Nephropsis* and *Ginkgopsis,* their belonging to the *Ginkgoales* is doubtful.(61) It is impossible, therefore, to consider the beginning of the genus *Ginkgo* as belonging to any period before the Lias.(40) The mistaken idea of the history of *Ginkgoales* led Chachloff to commit more historic errors with regard to *Ginkgo,* the development of *Ginkgo biloba* Linnæus, and the general evolutionary process where the fundamental evolutionary force is natural selection. Therefore, the most primitive forms do not survive the process of evolution; contrary to Chachloff's opinion the most prominent divergence may be continued or eliminated by natural selection, becoming, in other words, nonprimitive.

As an illustration of the above a description may be given of the *Ginkgo* species as described by Heer and other palæobotanists. Special attention should be given to the group he mentions,(20, p. 34) as—"in all cases we have the right to affirm that *G. integriuscula, G. primordialis, G. reniformis, G. adiantoides* and *G. biloba* are closely tied in relationship to each other and in genetical connection." But in this case it is better to begin by mentioning a species older than the above group; namely, *G. digitata* (Brgn.) Heer. The leaf of *G. digitata* is characterized by a cuneate base and a deeply lobed lamina. The lobulation is so far differentiated that the most prominently lobed leaves are scarcely to be distinguished from those from species of *Baiera,* to which they will be probably related in time. Heer(19) describes *G. digitata* of Cape Boheman as having four distinct forms according to the number and character of their lobes.

Nathorst(57) does not agree with the age of the deposits given by Heer and states that they belong to the Middle Devonian, a later epoch, but he considers that none of these forms has any systematic significance, because one can see a consecutive gradation between them.

The most-differentiated forms of this species are so unlike the genus *Ginkgo* that Seward is right in pointing out the impossibility of distinguishing *Ginkgo* and *Baiera* from one another by the shape of their leaves. For this reason this species, or some of the specimens belonging to it, may be intermediate

between these genera; and some of the other examples given by Heer and other palæobotanists without doubt belong to other species of *Ginkgo.*

Nathorst considers *Ginkgo integriuscula* a variety of the same species. It was described by Heer as being of the deposits already mentioned; namely, Cape Boheman, (19, p.44) and a year later (20, p. 25) from the Jurassic of Ajakit. On closer inspection, however, any distinction between it and *G. adiantoides* seems doubtful. Heer's description is as follows: "*Ginkgo* f. basi attenuatis, semicircularibus, indivisis margine hike inde leviter incisis, nervis numerosis, pluriis dichotomis, flabellato-divergentibus."

The specimens, as seen in one of Heer's drawings, (20, pl. 6, fig. 5) show no greater sinuses in the leaves than *G. adiantoides,* and further comment in reference to the sinuses in other drawings seems scarcely possible owing to their being in a damaged condition. An elongated base, as already mentioned, must be the predominant feature among the ancient forms of *G. adiantoides;* as it may also be observed in later specimens, it would be erroneous to affirm the presence of some special variety, as all other characters fully coincide with the permanent form of *G. adiantoides.* Heer himself, in another instance, came to the conclusion that the cuneiform base cannot be taken as a sufficient proof of a special species. *Salisburia borealis* Heer, the species described by him as of the lower Eocene of Disko Island and Atanekerdluk (13, p. 95) and the Cretaceous of Mgatsch, (21, p. 21) was rightly characterized by a cuneate base. ("Ginkgo f. cuneiformibus, apicem versus sensium dilatatis.") But in Miocene Flora of Sakhalin (21, p. 21) he said: "At an earlier period I described this form as S. borealis, but consecutive transitions belonging to S. adiantoides, as well as to the form now existent, lead me to the conclusion that it belongs to the G. adiantoides." The age of these findings, incidentally, was erroneously determined by Heer as the Miocene; the age quoted in this article is corrected according to Kryshtofovich. (42; 44, p. 4)

Gardner (10, p. 99) as well as Seward, (67, p. 30) who studied the authentic specimen brought by Heer from Greenland in the Kew herbarium, consider the species *G. adiantoides;* and my careful study of the authentic specimens, also brought by Heer from Mgatsch and now in the Museum of the Botanical Institute of the Academy of Sciences in Leningrad, confirms this opinion. The specimen II–8 (text fig. 2) may better be classed as *G. digitata* (Brgn.) Heer, while the three other specimens show the

transitional development from a well-defined cuneiform to a typical reniform leaf.

One of the specimens from the Cretaceous deposits near Bureya River (35) has also a well-defined reniform base, while on the other impressions from the same locality may be seen a narrower base. Heer (20, p. 32) deduced a new species with a reniform leaf base from the Tertiary (Palæogene, according to Kryshtofovich) deposits Tschirimy-Kaja—*G. reniformis* ("Ginkgo f. reniformis margine hike inde leviter, incisis, nervis numerosis, pluriis dichotomis, flabellato divergentibus petiolo tenui."). He considers

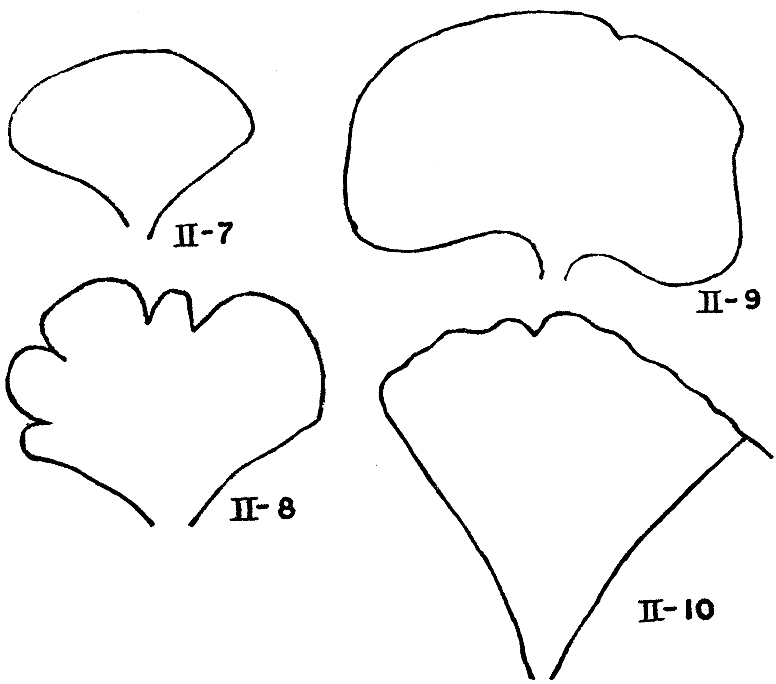

FIG. 2. *Ginkgo adiantoides* from Mgatsch. [After Heer, Flora foss. Arctica 5 (1878) pl. 2.]

the reniform base in this case as the principle character, but from my point of view I explain this phenomenon as being a sign of the later age of the deposits that contain this specimen. On closer observation of the given drawings (by Heer) we see a great difference between the venation of the leaves of *G. reniformis* (20, pl. 8, figs. 24, 25) and of the leaves of *Salisburia borealis.* (21, pl. 2, figs. 7–10) According to the drawings the latter seem to have a closer venation; but the original leaves, on careful study, prove to have the same venation as the leaves of *G. reniformis.*

Salisburia primordialis, of the Cretaceous of Atanekerdluk, (18, p. 100) is another species that Heer considers closely related to *G. reniformis,* because of the reniform lamina, although only part of the impression can be seen. For this reason Heer determines this species as an independent one, because the petiole at a distance of 1 centimeter from the lamina is seen as a small protuberance on a thicker axis of the 4-centimeter length. I think that this protuberance is due to crushing and not to normal growth. Seward, (68, p. 29) studying the original impressions in the Stockholm Museum, states that they have a longer axis, which probably has no connection with the leaf. For this reason I consider this impression to be *G. adiantoides.*

The study of the iconography of younger findings, by Heer, (24, pl. 87, figs. 9–12; 13, pl. 47, fig. 14) Ward, (77, pl. 31, figs. 5, 6) and Gardner, (10, pl. 25, figs. 1–5) gives a high percentage of well-formed reniform leaves. The same may be said of the impression of Kryshtofovich from the Eocene-Oligocene of Amagu River, (46, pl. 1, fig. 7) as well as those of Nathorst from the Senonian-Eocene of Svalbard (57, figs. 1, 2) where the cuneiform leaves are in excess by reason of their greater age.

The impressions figured by Heer from Atanekerdluk (14, pl. 45, fig. 1) and Puilasok (16, pl. 3, fig. 15) are very incomplete, and one may doubt their belonging to this species. A certain lobed configuration is noticeable in Gardner's magnificent specimens, as may also be seen in an impression of a Miocene specimen of Senigallia, which led Massalongo and Scarabelli to describe it erroneously as a new species—*Salisburia Procaccinii* Massalongo and Scarabelli. (56, p. 165, pl. 39, fig. 1) Schimper, (63, p. 356) Gardner, (10, p. 99) and Seward, (67, p. 30) as well as many other botanists, see no difference between this species and *G. adiantoides* (Unger) Heer.

The specimen of *Ginkgo adiantoides* (Unger) Heer of the Miocene deposits from Krymskaja Stanzia, found by Mr. Ivanchuk and lately studied by me, also shows a well-defined reniform base (Plate 1, fig. 4).

Among the impressions belonging to the Pliocene of Depape from St-Marcel d'Ardech and of Engelhardt-Kinkelin from Frankfurt on the Main, the two-lobed leaf is still better defined.

From the Laramie deposits Ward (77–79) described a new species, *G. laramiensis* Ward, as occupying an intermediate position between *G. adiantoides* and the contemporary species, *G.*

biloba Linnæus. Ward(79, p. 15) described *Ginkgo laramiensis* as follows: "Leaves small (3 to 5 cm. in width), narrowed to the petiole, the margin undulate, sinuate, or somewhat lobate; nerves flabellate-divergent, many times dichotomous."

"The occurrence of sinuses of variable depth at irregular intervals around the margins of the leaves is the chief distinction which separates this form from both *G. adiantoides* and *G. biloba*, between which it clearly holds an intermediate position." Ward's statement as to the intermediate position of the fossil between *Ginkgo adiantoides* and *G. biloba* was astonishing as the above-mentioned statements prove the unmistakable identity of these two species. Only the traditional views still held by palæobotanists have opposed the reduction of the name *G. adiantoides* to a synonym of *G. biloba*. There can be no question of an intermediate position where there is no interval.

Newsberry, as quoted by Ward himself,(79, p. 15) says that he "could find no sufficient characters to justify a specific distinction." In this connection Ward remarks: "There certainly is very little difference except in size, but between G. adiantoides and the living species there is not even that difference. I have therefore thought best to commemorate this small form by a separate name . . ."

In this case Ward's statement does not agree with what he wrote in the above where we read of *Ginkgo adiantoides* and *G. biloba* being intermediate. At the same time, it seems that these two species resemble each other more than either resembles *G. laramiensis*. Ward agrees that the difference between the species is slight, yet thinks it better to give the species a separate name. This is out of the question in view of the great variation of the leaves of *G. adiantoides* and *G. biloba*, noted earlier by Heer and by almost all the other specialists that have studied the ginkgo. Even the important characters—such as, sinuses and their depth, not to mention the size of leaf— are exceedingly variable. That species is also recorded by Knowlton(30, p. 31) from the Montana formation of beds included in the Laramie group.

Knowlton holds to Ward's opinion that the main difference is in size, "the leaves of *G. laramiensis* ranging from 30–40 mm. to 60–70 mm. in width and those of *G. adiantoides* from 75 mm. to 90 mm." Thus, the size of *G. laramiensis* is already augmented and equals the size of *G. adiantoides* for which the li-

mits are so abridged that one is obliged to think that the author in this case refers only to Gardner's specimens. In the shape of the leaf, Knowlton considers that the forms of this species are as different among themselves as those of the living species, and gives some drawings of the cuneiform and lobed leaf as well as the reniform and sinuous. He also affirms that the lamina of *G. laramiensis* does not seem as elongated towards the petiole as in *G. adiantoides.* This deduction, however, does not quite agree with his former opinion about the polymorphism of *G. laramiensis* leaves. The cuneiform base can be explained with success by assuming a more ancient origin, already mentioned. Comparison of the specimens given by Ward and Knowlton with the impressions of the same stratigraphic ages shows no difference in their shape. Seward(67) is right when he notes that *G. laramiensis* cannot be distinguished from *G. adiantoides* by any definite characters. Therefore, we have come to the conclusion that *G. laramiensis* is nothing but a synonym of *G. adiantoides.* In this way we may refer to a series of impressions from Sakhalin of the Cretaceous period, given by Kryshtofovich,(43, 45) as *G. laramiensis.*

In conclusion, a diagnosis of *G. adiantoides* may be given, taking into account the dynamism of the characters during a period of the life of this species.

Heer's(17, p. 14) diagnosis is as follows:

"f. late-rhomboideo-subreniformibus, in petiolum longum angustatis, margine undulatis, nervis flabellato-divergentibus pluriis dichotomis."

The diagnosis given by Massalongo and Scarabelli(56) is more complete, but also has some defects, as follows:

"f. late-rhomboideo-flabelliformibus, bipollicaribus in petiolum angustato-attenuatis, integris, apice undulato-sinuatis lobulatis flabellatim nervoso-striatis, nervis dicranodromis tenuissimi, strictis, parallelis sursum dichotomis."

The following table may be adduced to limit the species. The characters of the lamina shape are as follows:

In ancient forms.	In younger forms.
Fan-cuneate.	Reniform.
Dissected into two halves or incised to several more or less angular lobes.	Bilobed or entire.
With a cuneate bases gradually passing into a petiole.	Horizontal or cordate.

The diagnosis is as follows:

GINKGO ADIANTOIDES Unger sp. em. Shaparenko.

Salisburia adiantoides UNGER, Gen. et Spec. foss. (1850) 392.
Salisburia Procaccinii MASSALONGO and SCARABELLI, Fl. Senogall. (1858) 163.
Salisburia borealis HEER, Flora foss. Arctica 1 (1868) 95.
Ginkgo adiantoides (Unger) HEER, Flora foss. Arctica 3 (1874) 14.
Ginkgo primordialis HEER, Flora foss. Arctica 3 (1874) 100.
Ginkgo integriuscula HEER, Flora foss. Arctica 4 (1877) 44.
Ginkgo reniformis HEER, Flora foss. Artica 5 (1879) 32.
Ginkgo laramiensis WARD, Syn. of the Laramie Group (1885) 549.

Ginkgo foliis 3 ad 9 cm flabellato-cuneiformibus vel reniformibus; laminis subbipartitis vel multifidis vel subbilobis vel integris; margine irregularibus, undulatis vel planis; basi cuneiforme-angustatis vel subcordatis, nervis digitato-divergentibus numerosis dichotomis; interduum ductis secretoriis linearibus, nigris, brevibus, ab angulis nervorum excuntibus.

Ginkgo with leaves varying considerably from fan-cuneate to reniform; with lamina from dissected into two halves or incised into several more or less angulate lobes to bilobed or entire; with the base cuneate to cordate. Upper margin usually somewhat uneven and irregular in outline, undulated or plain. Leaves 3 to 9 centimeters wide, nerves flabellate-divergent, numerous, often dichotomous, occasionally with short secretory canals seen as short dark lines coming from the forks of the veins.

A chronologic table of the finds of *Ginkgo adiantoides* Unger sp. em. Shaparenko is given here. This paper and the following table do not give a detailed account of the ginkgo, but everything quoted has been minutely studied under special control and mistakes have been eliminated or given with an interrogation mark.

List of finds of Ginkgo adiantoides (Unger) sp. em. Shaparenko.

THE JURASSIC.

Ajakit, Siberia. Heer (1878) (1) 25, pl. 6, figs. 5, 6. "*G. integriuscula.*"

Cape Boheman, Svalbard. Heer (1877) 44, pl. 10, figs. 7–9; Heer (1878) (1); Nathorst (1919) considers this find between the Jurassic and the Cretaceous (Portlandian-Wealden).

THE CRETACEOUS.

Mgatsch, Sakhalin. Heer (1878) (2) 21, pl. 2, figs. 7–10. "*S. borealis.*" Heer gives mistaken data in referring this find to the Miocene. Kryshtofovich (1918); (1921) (1) 4.

Makai, Sakhalin, Japan. Kryshtofovich (1918).

Atanekerdluk, Greenland. Heer (1874) (3) 100, pl. 27, figs. 1–3; (1882). "*S. primordialis.*"

THE UPPER CRETACEOUS.

Bureya River, Siberia. Konstantow (1914) pl. 4, figs. 2, 5, 6. Erroneously refers to the Miocene (Kryshtofovich (1931).

Alexandrovka River, Sakhalin. Krystofovich (1921) (2). "*G. laramiensis.*"

Ludvigova pady, Sakhalin. Kryshtofovich (1921).

Nainai River, Sakhalin. Kryshtofovich (1921).

Komarinyi source, Sakhalin. Kryshtofovich (1921).

Point of Rocks, Wyoming. Ward (1884–5) pl. 31; (1887). "*G. laramiensis.*"

South Dakota. Knowlton (1911). Lance formation.

Glasgow, Montana. Knowlton (1911). Lance formation.

Sand Creek, above Glendive, Montana. Knowlton (1911). Lance formation.

Weston County, Wyoming. Knowlton (1911). Lance formation.

Big Horn Basin, Wyoming. Knowlton (1911). Lance formation.

THE TERTIARY. The lower strata (Eocene, possibly the Cretaceous). Conventional symbol on the map: "1."

Braganza Bay, Svalbard. Nathorst (1919).

Green Harbor, Svalbard. Nathorst (1911).

THE PALÆOGENE. Conventional symbols on the map: "2–4."

Uglovaia Bay, Siberia. Stempel (1926).

Tschirimyi Kaja, Siberia. Heer (1878) (1) 32, pl. 8, figs. 24, 25. "*G. reniformis.*"

THE LOWER EOCENE.

Atanakerdluk, Greenland. Heer (1868) pl. 47, fig. 14; (1869) (1) pl. 44, figs. 1–?; (1874) (2); (1883). "*S. borealis.*"

Disko, Greenland. Heer (1874) (1) pl. 3 figs. 15–? (1874) (2); (1883); (1868) pl. 2 fig. 1; "*S. borealis.*"

Hasen, Greenland. Heer (1883).

(Mistaken data of all three as the Miocene.)

Seven Mile Creek, near Glendive, Montana. Ward (1884–5) pl. 31, figs. 5, 6.

THE EOCENE OR OLIGOCENE. Conventional symbols on the map: "3–4."

Mgatsch, Sakhalin. Krystofovich (1921) (4).

Dui, Sakhalin. Kryshtofovich (1921) (4); (1918).

Amagu River, Siberia. Kryshtofovich (1921) (1) 11; (1921) (2); (1921) (3).

Sitka, Alaska. Knowlton (1894) (1); (1894) (2). The Eocene.

Herendeen Bay, Alaska. Knowlton (1894) (1); (1894) (2). The Eocene.

Porcupine Creek, Alberta. Knowlton (1919). The Eocene.

Great Valley, Alberta. Knowlton (1919). The Eocene.

Tulamen, British Columbia. Knowlton (1919). The Oligocene.

Horsefly River, British Columbia. Knowlton (1919). The Oligocene.

Samland, East Prussia. Heer (1868); (1869) (2) 11. (?)

Ardtun Head, Isle of Mull. Gardner (1886) pl. 25, figs. 1–5. The Eocene.

Bovey-Tracey, England. Heer (1861). The Eocene.

Sterlitamak, Bashkiria. Kryshtofovich (1932) (1).

THE MIOCENE.

Krymskaja, Northern Caucasus. Collected by P. K. Ivanchuk.

Dolja, Yugoslavia. Pilar (1883).

Senigallia, Italy. Massalongo and Scarabelli (1858) "S. adiantoides," pl. 39, fig. 12, pl. 7, fig. 2, pl. 6, fig. 13; "S. Procaccinii," pl. 39; Unger (1845, 1847).

Parschlug, Styria. Unger (1845, 1847, 1848, 1850).

THE PLIOCENE.

St. Marcel, France. Depape (1913, 1922). The Lower Pliocene.

Privas, France. Boulay (1887); Depape (1913).

Klarbecken, Germany. Engelhardt and Kinkelin (1911), pl. 23, fig. 18, *a*. The upper Pliocene.

THE QUARTERNARY.

The homestead Astashikha (mouth of Bureya River). Kryshtofovich (1915, 1932) (2).

In studying the large area from which *Ginkgo adiantoides* is mentioned in the foregoing list one is struck by the incompatibility of climatic conditions in which *G. adiantoides* grew in former days, as compared with the present climatic zones in which the remains of the ginkgo are found. Apparently the biology of the ginkgo now extant, by which we determine the fossil, is to a great extent unlike the latter, or the climatic zones in the past geologic epochs were subjected to great shifting. The first supposition is very unlikely. It is difficult to fix a certain regularity in the wide-spread growth of *Ginkgo adiantoides* and the solitariness of geographic points, in which its traces are found. This solitariness, when we observe it in one continent, is undoubtedly due to want of knowledge of the fossil flora.

However, it is more difficult to explain the wide distribution of the ginkgo, considering the geographic barriers in the way of its diffusion. Here must be pointed out the methodologic mistake causing the difficulty; namely, the study of palæogeographic questions with contemporary maps. Land vegetation of ancient geologic periods should be studied and determined according to maps of the periods in question. The facts already quoted might be explained most clearly by the distribution of dry land and climatic zones in the manner proposed by Köppen-Wegener's theory.(38) The isolated habitats of *Ginkgo adiantoides* as perceived in that light are latitudinally situated in geographic parallels of corresponding geologic periods. A glance at a contemporary map showing latitudes of the ancient geologic periods (text fig. 3), which I have computed according to Köppen-Wegener, and at the finds of *G. adiantoides*, shows a well-

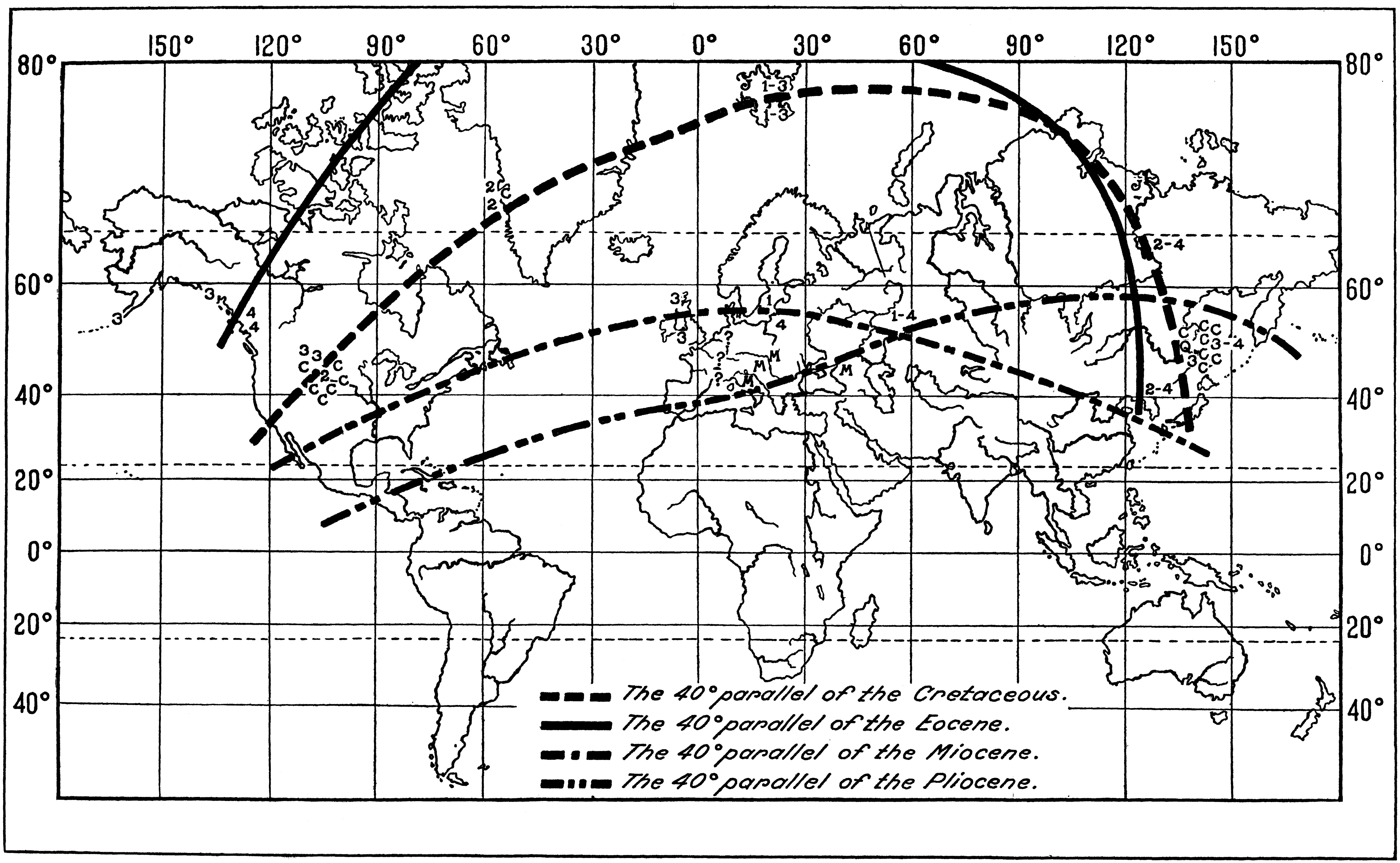

FIG. 3. Locations of *Ginkgo adiantoides* Unger and position of the 40° parallel in different geologic epochs, according to Köppen and Wegner. The 40° parallel of the Jurassic is not plotted because it almost coincides with that of the Cretaceous. The letters and numbers refer to ages of locations in sequence, as follows: J, Jurassic; C, Cretaceous; 1, Cretaceous or lower Eocene; 2, Lower Eocene; 3, Eocene; 4, Oligocene; M, Miocene; P, Pliocene; Q, Quarternary. Hyphenated numbers refer to ages of locations not precisely determined.

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defined connection in the latter, so that the acceptance of this theory is justified in the present treatise.

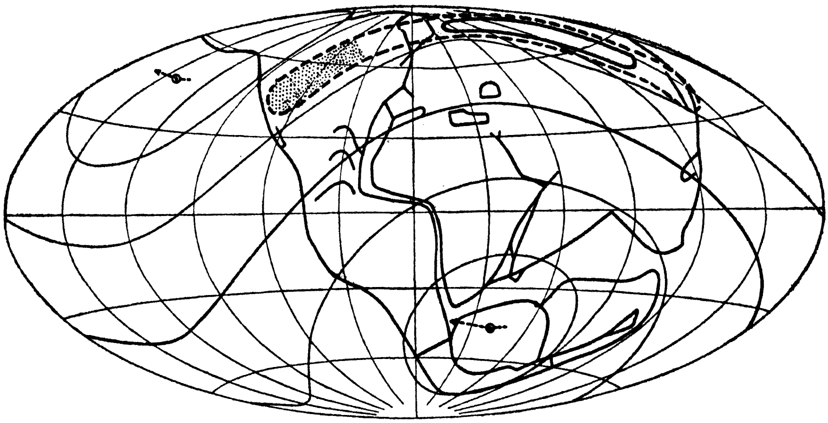

FIG. 4. Areas of *Ginkgo adiantoides* Unger in different geologic periods. The geographic network (0°, 30°, 60°) and the shapes of the mainlands are those of the Cretaceous.

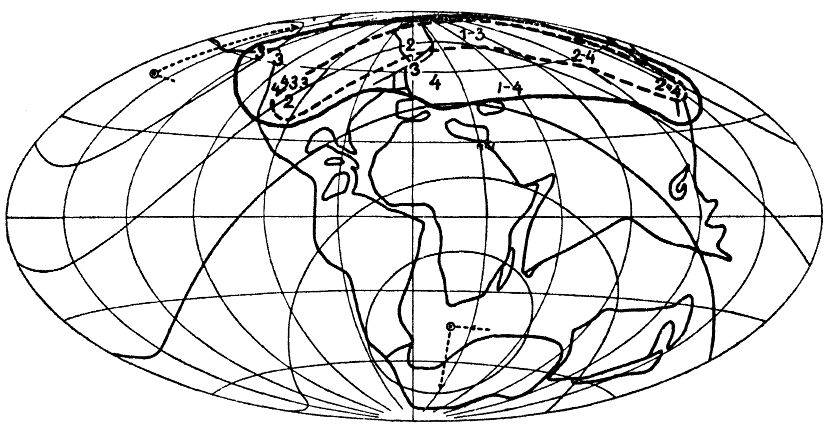

FIG. 5. The Cretaceous and the Eocene-Oligocene areas. The geographic network and the shapes of the mainlands are those of the Eocene.

The most ancient finds of this species (Ajakit, Cape Boheman) are located in the tertiary of Angarida, seemingly the center of the growth of this species. According to Wegener this region should have lain at about 40° north latitude, which almost coin-

cides with the latitude of the area of the living species now growing in a half-wild state.

We come upon fossils of *G. adiantoides* in the Cretaceous outside this region; for example, in the Cretaceous and Upper Cretaceous of the Far East, in the Cretaceous of Greenland and in the Upper Cretaceous localities in Montana, Wyoming, and South Dakota (text figs. 3 and 4). Greenland and North America and ancient Angarida must have been connected by dry land to explain the diffusion of this species, unless we consider it as being of pantropic origin, for which we have no foundation.

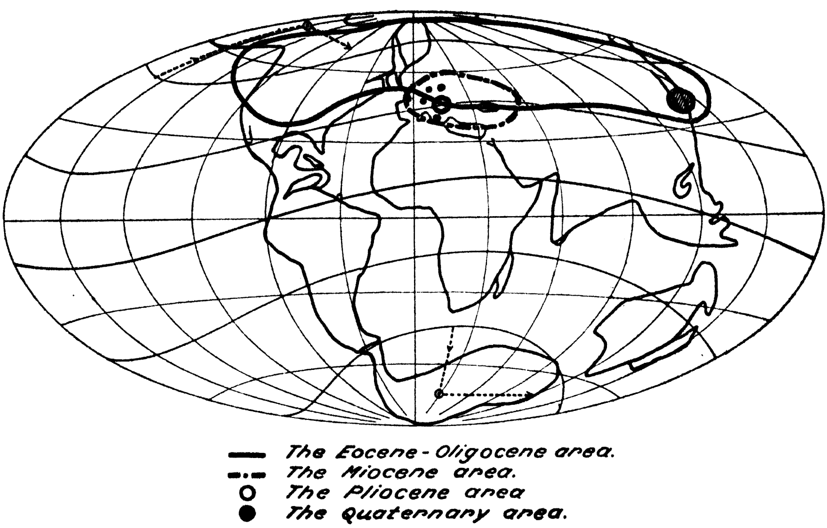

FIG. 6. The Eocene-Oligocene, Miocene, Pliocene, and Quaternary areas. The geographic network and the shapes of the mainlands are those of the Miocene.

Knowlton (33, pp. 44 and 45) remarks that the seeds of the gymnosperms of that period, including the ginkgo, cannot withstand sea water for any length of time; hence, dissemination by way of ocean currents is improbable. Knowlton is mistaken in considering that Mammifera did not exist among the fauna of that period;[2] but they were as yet imperfect and not widely distributed, and therefore cannot be looked upon as a serious factor in the diffusion of seeds; *Archæopteryx* was the only avian genus represented. The seeds could not have been transferred by the wind to any great distance as they were not supplied with pappus or other means by which they could be carried; therefore,

[2] The first signs of the Mammifera are traced in the Jurassic; that is, Multituberculata, Polyprobodontia, and others. See Yakowlew (1932).

the only seemingly valid theory is that of a land connection then existing between the continents. As may be seen by Wegener's scheme there must have been an indissoluble connection between these points, broken only in the Quaternary period when Greenland and North America were detached from Europe. One must also take into consideration the propagation of the species in unrelenting conformity with the zonal low towards the East and South of the Angar center. No obvious change in the meridional direction has been noted in the period between the

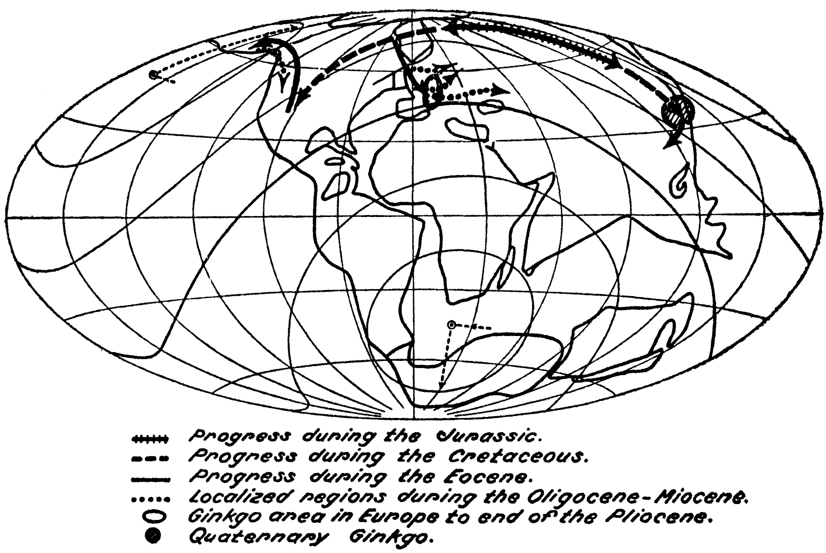

FIG. 7. The distribution of *Ginkgo adiantoides* Unger in different geologic periods. The geographic network and the shapes of the mainlands are those of the Eocene. The distribution was effected by means of the connections between continents. The map shows the progress of distribution during the Jurassic, the Cretaceous, and the Eocene, the region in which the plant was localized during the Oligocene-Miocene, the ginkgo area which remained in Europe to the end of the Pliocene, and the Quaternary ginkgo area.

Jurassic and the Cretaceous, and according to Wegener climate changed very little during that time.

In the lower Tertiary we find the ginkgo in the region of its primary center (Tschirimy-Kaja, Svalbard). According to Wegener the climatic changes to the Eocene on this part of the 40th parallel were insignificant as to cold (figs. 7 nd 8), which may explain the growth of the ginkgo in the same area; it may be slightly tending towards the Equator (seen on a contemporary map to the south; Amagu River, Uglovaia Bay). One may

follow a more-pronounced trend in North America (Seven Mile Creek in the lower Eocene; Green Harbor; Porcupine Creek, Herendeen Bay, and Sitka, in the Eocene), but only in a contrary path northward. In the Tertiary of North America, according to Wegener, a greater change could be remarked towards warmer conditions, which reached their culminating point in the Eocene. Violent changes towards cold in the Miocene characterized the climate of the Eurasian continent with the exception of its extreme southeastern limit. North America proves to have experienced the cold to a less extent. These changes and consequent glaciation were the cause of the ginkgo's migration in a converse direction. *Ginkgo adiantoides* thrived in the latitude corresponding to British Columbia and we find it also in Sterlitamak. British finds belong either to this period or represent somewhat more of the species resistant to heat, which had penetrated in the Miocene in territories where the heat was too great at that time (30th parallel). The last supposition may be true, as we find *G. adiantoides* in the Miocene of Europe in a latitude south of 40° (Krymskaja, Dolja, Senigallia, and Parschlug; text figs. 3 and 5). In the greater part of Asia and America the climatic change to cold was so great as to exterminate *G. adiantoides* before its migration to the south could be effected, because of the massive range of mountain land in central Asia and the vast plains of North America. Wegener's theory throws light on the matter and explains all the questionable points in the palæogeographic history of plants. Towards the end of the Tertiary—that is, the Pliocene—*G. adiantoides* was unable to cope with the cold, which eventually caused its extinction in America. There remains a small isolated patch of land where we see the latest and seemingly the last remains of *Ginkgo adiantoides* in Europe (text fig. 6). The great glaciation advancing from the northwest abolished the Pliocene flora of the northern and western parts of the mainland or forced it to migrate to the southern borderlands of the Eurasian and North American mainlands.

A study of the climatic and geographic elements that *G. adiantoides* was obliged to meet in those borderlands is necessary in order to understand its further distribution. In the Mediterranean the Tertiary flora was abolished by an earlier advanced exsiccation, after which the land became the shelter of a special Mediterranean flora.(43) The alluvial plains near the Pyrenees, the plains of the Cordilleras, and the affluent tributa-

ries of the Mississippi, in their climatic conditions, seemingly proved unsuitable for *Ginkgo.* Climatic conditions in this periglacial zone, in the glaciation of the mainland as well as of the interior mountains, as described by Tutkowsky(72) and later by Brooks(4) and Hobbs(25) [see also Litchkov (1931) and Grigoriew (1930)], were characterized by cold dry winds blowing from the ice fields and destroying all vegetation. Whether deserts with a hot climate have ever existed, as supposed by Tutkowsky, or peculiar dry regions with a frosty climate, as maintained by Hobbs, by Litchkov, and by Grigoriew, and named by the last "Arctic Steppes," is of no vital importance to us, insofar as these scientists agree on the point characterizing these regions as "dry," making them unsuitable not only for *Ginkgo adiantoides,* but also for all afforestation. According to Litchkov the northern part of the Eurasian mainland in the Quaternary presented an almost continuous chain of ice fields from Scandinavia to Enisey River, south of which lay great alluvial plains. Opposed to these in consecutive order lay a second chain of alluvial plains formed by the ice-bound Caucasus, Pamir, Tian Shan, and Altai Ranges, almost in touch with the former. These plains gave rise to the wilderness of our day and the steppes of Manitcha, Karakouma, Kisil-kouma, Semiretchie, and Koulounda. Litchkov(54, p. 99) gives us the following:

"We may think that the great territories of the U. S. S. R. in Europe and in Western Siberia as well as the plains of the Touran—collosal alluvial plains, are created by the waters proceeding from the ice-fields of the mainland's glaciation in the North and those of the mountain ice-fields in the South [text fig. 8].

"Looking at this question in that light it is possible to conceive the well known zoögeographical fact that the limit for the fauna, separating Europe from Asia does not run along the Ural, but much further to East—along the Enisey. The reason of this seems clear as the great alluvial plains terminate at the Enisey, after which begins the lofty watershed plateau."

The ice-bound territory in eastern Asia was not so large as in Europe or western Siberia,(54, p. 100) for its configuration and seaboard made climatic conditions less continental but warmer and damp (Grigoriew).(11, p. 89, 90) The conditions in this place were more favorable for the preservation of *Ginkgo* in the Quaternary, and here in eastern Asia the Quaternary

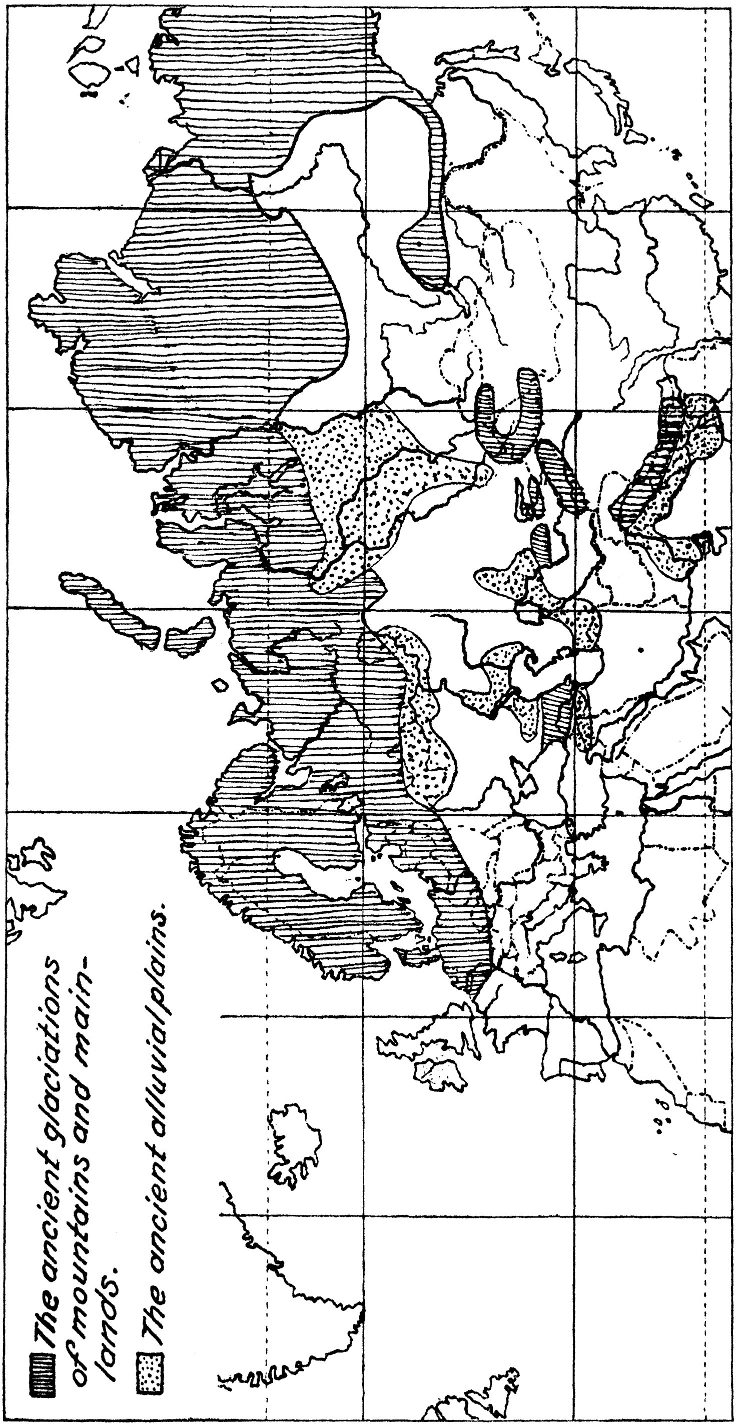

FIG. 8. Glaciation of the Quaternary in Eurasia. The map shows the ancient glaciations of mountains and mainlands and the ancient alluvial plains. [After Litchkov (1932), Tolmatchev (1931), and others.]

remains of *Ginkgo adiantoides* (in the farm of Astashikha, not far from the mouth of Bureya River) were found.(41, 52) In this zone existed the possibilities of a wider throw and quicker migration south from the ever-increasing cold; here also there was the least change in climatic conditions; but, notwithstanding these facts, the ginkgo could not have contended long with the gymnospermous flora, which had by that time reached a luxurious development, but was doomed to die out if there had not appeared in the Quaternary a new and mighty factor, which interferred in the balance of nature; namely, man and his culture. That culture came from the East, and with it the struggle for life and natural selection underwent a radical change, the latter to a great degree giving way to artificial selection or change in character. Biologic processes in nature change their course according to the direct or indirect will of man. Some plants are ruthlessly destroyed, others are on the path to extermination, but if able to serve him for some given profit are saved, cultivated, and borne through all the continents, losing the elements that at first tied them to their natural home and primordial forms as may be seen in many examples of vegetable life and as well in *Ginkgo adiantoides.* At present *Ginkgo adiantoides* is cultivated and growing in almost all botanic gardens of Europe and North America, winning back its former areas and glory.

Such is the evolution of *Ginkgo* in different geologic epochs. It is, however, but a fragment from the leaf of time that could be devoted to the whole group of the ginkgoes; as yet the systematically organized analysis necessary for such an extensive task is lacking. Therefore, it is interesting to make a comparison of some deductions based upon the study of our little group with analogous investigations of the cycads and conifers.

Koch(36) demarks the origin of the conifers as being in the center of the territory adjacent to the Carboniferous equatorial belt. The species need heat far more than the ginkgoes. In the period when *Ginkgo adiantoides* came into being in the Jurassic the cycads had already migrated from subtropical Europe and penetrated North and, later, South America as well as adjacent islands. They penetrated East Africa, Madagascar, India, and Australia, which formed at that period one continent. The cycads migrating from East Africa to Australia did not attempt to thrive in the Antarctic Continent in apposition to the conifers,

which, coming into being at a later period after the subdivision of the African Continent and the falling away of Madagascar, India, and Australia, were able to penetrate only through the Antarctic Continent. The diffusion of our species of *Ginkgo* began later in the Cretaceous, by reason of which it could penetrate no farther than North America and eastern Asia. According to Koch the cycad during its diffusion coincided with the shifting of the subtropical zones, which is true also of the ginkgo. Koch holds to the same opinion as we do, according to which the cycad began to die out during the Eocene shifting of the pole to the neoteric.

Interesting deductions may be made from Studt's history of the conifers (70) as seen in the light of Wegener's theory. Studt is of the opinion that the conifers came into being in the northern extratropical zone and divides the development of the species into three phases: The first, from the Carboniferous to the Triassic, before the appearance of our species; the second phase coinciding with the appearance of our species, characterized by the wealth of the conifers, in Europe; the third phase falls in a colder period, which caused the extinction of conifers in Europe, although Studt notes that they might have been preserved in eastern Asia and North America. Studying the shift of the areas in different geologic periods Studt observes their asymmetry, pointing to the fact that for many kinds of species migration took place in Europe and North America, excluding eastern Asia.

Both Studt and Koch agree with Wegener's theory and believe that all the mainland formed one unit until its shift in relation to the pole and disintegration into smaller continents.

In conclusion I should like to express my obligations to Professor Palibin, who has kindly favored me with valuable suggestions during the course of my work, and to Professor Wulff, to whom I am deeply indebted for giving me further incentive in my work on geographic research.

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ILLUSTRATIONS

PLATE 1

FIG. 1. *Ginkgo biloba* Linnæus, from Adzharistan; leaves belonging to a 1-year-old plant.

2. *Ginkgo biloba* Linnæus, from Adzharistan; leaves belonging to a 2-year-old plant.

3. *Ginkgo biloba* Linnæus, from Adzharistan; leaves beloning to an old plant.

4. *Ginkgo adiantoides* Unger, from Krymskaya Stantzia.

TEXT FIGURES

FIG. 1. Leaves of *Ginkgo biloba* Linnæus, from the forest institution in Weener (Hannover). The leaves of the upper and middle rows belong to branches 1 year old; the lower row grew on older branches. [After Kräusel, Centralbl. für Mineral. (1917).]

2. *Ginkgo adiantoides* Unger, from Mgatch. [After Heer, Flora foss. Arctica 5 (1878) pl. 2.]

3. Locations of *Ginkgo adiantoides* Unger and position of the 40th parallel in different geologic epochs, according to Köppen and Wegener. The 40th parallel of the jurassic is not plotted because it almost coincides with that of the Cretaceous. The letters and numbers refer to ages of locations in sequence, as follows:

J, Jurassic.	3, Eocene.
C, Cretaceous.	4, Oligocene.
1, Cretaceous or lower Eocene.	M, Miocene.
	P, Pliocene.
2, Lower Eocene.	Q, Quaternary.

Hyphenated numbers refer to ages of locations not precisely determined.

4. Areas of *Ginkgo adiantoides* Unger in different geologic periods. The greographic network (0°, 30°, 60°) and the shapes of the mainlands are those of the Cretaceous.

5. The Cretaceous and the Eocene-Oligocene areas. The geographic network and the shapes of the mainlands are those of the Eocene.

6. The Eocene-Oligocene, Miocene, Pliocene, and Quaternary areas. The geographic network and the shapes of the mainlands are those of the Miocene.

7. The distribution of *Ginkgo adiantoides* Unger in different geologic periods. The geographic network and the shapes of the mainlands are those of the Eocene. The distribution was effected by means of the connections between continents. The

map shows the progress of distribution during the Jurassic, the Cretaceous, and the Eocene, the region in which the plant was localized during the Oligocene-Miocene, the ginkgo area which remained in Europe to the end of the Pliocene, and the Quaternary ginkgo area.

FIG. 8. Glaciation of the Quaternary in Eurasia. The map shows the ancient glaciations of mountains and mainlands and the ancient alluvial plains. [After Litchkov (1932), Tolmatchev (1931), and others.]

PLATE 1.

CONTROL OF BACTERIAL FRUITLET ROTS OF THE PINEAPPLE IN THE PHILIPPINES [1]

By F. B. SERRANO [2]

Of the Bureau of Science, Manila

ONE PLATE AND TWO TEXT FIGURES

INTRODUCTION

The bacterial fruitlet rots of the pineapple, (14, 15) particularly the fruitlet black-rot of the Smooth Cayenne variety caused by *Phytomonas ananas* Serrano, are the worst diseases known to affect pineapple fruits in the Philippines.

From 1927 to 1930 between twenty-seven and fifty-five of every hundred fruits were found infected to a greater or lesser degree by either one or both of the maladies, twelve or more of which generally represented a total loss. As the destructive effects of such infections are enough to cause serious apprehension with regard to the future of the industry, the exploitation of all possible ways and means of control was undertaken as presented in this report.

FACTORS FAVORING FRUITLET ROTS

A more or less thorough study of the different phases of the problem revealed that there are at least four factors—two agronomic, one environmental, and one physicochemical—that favor these diseases; namely, incomplete closing of the eyes, fewness of shoots, high temperature, and low acidity of the fruit.

Incomplete closing of the eyes.—The "eyes" in which the flowers are inclosed prior to and during blooming time represent in reality the outgrowth of the fruitlets composing the fruit. They are covered with bracts, which remain partly open during anthesis and close more or less completely as the flowers begin

[1] This paper is a continuation of the two papers on the bacterial fruitlet rots of pineapple published in the Philippine Journal of Science. (14, 15)

[2] The writer wishes to express his gratitude to the Philippine Packing Corporation for its valuable help in carrying out the field investigations. Thanks are also due Dr. G. O. Ocfemia, of the College of Agriculture, Los Baños, for reading the manuscript.

to wither. There are individual fruits, however, that do not entirely close their eyes even at maturity, either because of a natural-inherited trait, or because of some physiologic disturbance or pathologic affliction. Such loose-eyed fruits were found more heavily infected by the bacterial fruitlet-rot diseases than the tight-eyed fruits.

Fewness of shoots.—Strains of the Smooth Cayenne variety were found to vary in their capacity to produce suckers, shoots, hapas, and slips. The strain that produces an abundance of shoots around the fruit holds the fruit erect, with its crown protecting it more or less from direct sunlight; whereas the strain with but a few shoots generally has the fruit inclined or bent to one side, exposing the upper side to the direct heat of the sun. This exposure to the direct heat of the sun raises the temperature of the fruit, scorching it sometimes and creating a favorable condition for the activities of those bacterial pathogens that require a high temperature for their optimum development.

High temperature.—Experiments have shown that the optimum temperature for both *Phytomonas ananas* Serrano(14) and *Erwinia ananas* Serrano(15) lies between 31° and 33° C. Actual field observations show that during the hot months of the year and in places where the average daily temperature is high, the bacterial fruitlet-rot infections are more prevalent. Therefore, plantings at lower elevations are more severely attacked than those at higher elevations or about 2,000 feet above sea level, where the average daily temperature is comparatively low.

Low acidity of the fruit.—Of all the factors favoring the incidence of bacterial fruitlet rots, particularly the fruitlet blackrot caused by *Phytomonas ananas* Serrano, perhaps the most important is low acidity in the fruit. Wells et al.,(22) in their article on the composition of Philippine pineapples, reported that the healthy fruits are more acidic than the diseased fruits; that a comparison between the fruits of the native varieties and those of the Smooth Cayenne, between the large and the small fruits, between the shaded and the exposed fruits, and between the upper half and the lower half of the fruits, revealed that individually or collectively, the first is more acidic than the second in every case. Both field and laboratory studies have shown that fruits or parts of fruits with higher acidity suffer less from the ravages of the bacterial fruitlet-rot diseases. These observations seem to agree well with the results obtained from the cultural studies of the bacterial pathogens(25, 26) that

an acidity of about pH 3.7 is strong enough to inhibit their growth and development, their optimum reaction lying between pH 5 and 6.

It was also noted that no fruits as acid as pH 3.7 or more showed any infection. This evidence explains why, in Hawaii, where the acidity of the Smooth Cayenne fruits averages between pH 3.6 and 3.8, the bacterial fruitlet-rot diseases are mild.

CONTROL MEASURES

It seems that elimination of the favorable factors would greatly minimize the ravages of the diseases. Previous experiments (14, 15) have shown that the bacterial pathogens gain entrance into the fruitlets during the development of the fruit through different avenues; namely, through decaying flower parts, through ruptured fissurelike slits running from the eye cavities to the placental lobes, and through mechanical cracks that are generally present in the eye cavities of large succulent fruits. These facts suggest the possibility of immediate control through the use of fungicides during fruit development. Spraying was, therefore, tried, first alone, and then hand in hand with other experiments aiming at the elimination of factors favoring these maladies.

SPRAYING

Several fungicides, such as Bordeaux mixture, lime-sulphur, copper sulphate, mercuric chloride, and Semesan, of various concentrations, were tried at different times and in different localities.

EXPERIMENT 1

The first field trial was made in Calauan, Laguna Province, Luzon, in February, 1927, and the second in Makar, Cotobato Province, Mindanao, in March, 1928; lime-sulphur was used in both cases. There was practically no rain during the days covered by the spraying calendar. There was, however, fairly high humidity, as is typical of the locality.

Materials and methods.—The Smooth Cayenne field used in Calauan, Laguna, consisted of six single rows about 100 meters long and about 1 meter apart, with the plants in the rows spaced at 0.5 meter. With a compressed-air sprayer (Plate 1, fig. 1) spraying was started as soon as the flowers began to open. Row 1 was sprayed weekly for two months with tap water as check; row 2, weekly for two months, with lime-sulphur (33°

Baumé) at 1: 40 dilution; row 3, biweekly for two months, with 1 : 40 lime-sulphur; row 4 monthly for two months, with 1 : 40 lime-sulphur; row 5, weekly for two months, with 1: 60 lime-sulphur; and row 6, weekly for two months, with 1: 80 lime-sulphur. In every instance care was taken to cover thoroughly the flowers and small leaves around the fruit with the fine mist of the spray solution.

In the second field trial made in Makar, Cotobato, 1: 70 lime-sulphur (33° Baumé) was used at weekly intervals for two months on every other double row (56 by 22 by 18 inches) in a trial field of Smooth Cayenne belonging to the Philippine Packing Corporation, leaving the alternating rows unsprayed as check.

Results.—The fruits were picked by the row after approximately five months or as soon as signs of ripening were noticed, cross-cut into slices 1 to 2 centimeters thick, and all internal discolorations noted as shown in Table 1.

The results obtained from the preliminary spraying experiments, as shown in Table 1, strongly indicate that bacterial fruitlet-rot infections can be reduced to the minimum by spraying, and that lime-sulphur spray offers great possibilities as an effective means of control. It may be noted that a 1: 70 lime-sulphur (33° Baumé) solution applied weekly for two months during the blooming period gave the most effective control. On the other hand, a 1 : 40 dilution was not as effective, and produced considerable scorching on flowers and tender leaves and a decided stunting of the fruits.

EXPERIMENT 2

Experiment 2 was conducted in the pineapple plantations of the Philippine Packing Corporation in Bukidnon Province to compare the efficiency of lime-sulphur and Bordeaux mixture. The lack of sufficient plant material at the time prevented the writer from including various kinds of sprays as originally planned. Hence, only three series were included in this experiment, conducted at different times. The first was conducted in September, 1928, and the second, in April, 1929, both at Diklom, Tangkulan; the third was carried out in April, 1929, in field 1 at Santa Fe. The first happened to coincide with rather wet days, and the second and third, with moderately dry days.

Materials and methods.—In the first series Bordeaux mixture of 3–3–50 formula was compared with lime-sulphur (33° Baumé) of 1: 70 dilution; the former was applied thrice a week for five

TABLE 1.—*Results of lime-sulphur spraying for the control of bacterial fruitlet rots.*

Locality.	Spray solution.	Dilution.	Frequency of application.	Fruits observed.	Pathologic observations.				Efficacy of control.
					Healthy.	Slightly infected.	Severely infected.	Total loss.	
					Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calauan, Laguna	Check (tap water)		Weekly	22	63.6	18.2	9.1	9.1	
Do	Lime-sulphur (33° B.)	1:40	do	30	93.3	6.7	Nil.	Nil.	81.6
Do	do	1:40	Biweekly	26	84.6	11.6	3.8	Nil.	57.7
Do	do	1:40	Monthly	21	80.9	19.1	Nil.	Nil.	47.5
Do	do	1:60	Weekly	38	94.7	5.3	Nil.	Nil.	85.4
Do	do	1:80	do	44	93.2	6.8	Nil.	Nil.	81.3
Makar, Cotabato	do	1:70	do	120	96.6	2.6	0.8	Nil.	90.6
Do	Check (not sprayed)		do	128	63.8	24.4	10.1	1.7	

weeks during the blooming period on the first four double rows (56 by 22 by 18 inches), and the latter, on the third four double rows, skipping the middle four double rows as check. In the second series the same spray solutions of weaker concentration were used twice a week, side by side, on a ratoon instead of a plant crop. The Bordeaux mixture applied had the formula 3–2–50, and the lime-sulphur was a 1: 80 dilution. The third series was a repetition of the first in every way except that the strength of the Bordeaux mixture was increased to 3–4–50; the lime-sulphur remained at 1 : 70.

Results.—Upon ripening, all fruits in the experiment were picked separately by the row and cross-cut into slices 1 to 2 centimeters thick for pathologic observations, as shown in Table 2.

Table 2 shows that on the whole Bordeaux mixture is a better spray than lime-sulphur for the control of bacterial fruitlet rots. Spraying three times a week with either seems unnecessarily frequent and causes stunting of the fruits, as revealed by their reduced weights. Of the three strengths of Bordeaux spray tried, the 3–4–50 formula seems best. Another thing to be noted is the general lower efficiency of the whole batch of trials as compared with the results of previous experiments. Such a decrease may be attributable to the difference in the climatic conditions obtaining at the time of the experiments in the respective localities. While there had been practically no rain in Calauan, Laguna Province, and in Makar, Cotabato Province, when the first spraying experiment was in progress, Bukidnon had quite an abundance. The reduced efficiency is attributed to frequent rains, which to some extent wash off the protective covering of the spray, especially when the rain occurs during or soon after spraying.

EXPERIMENT 3

Due to the encouraging results of the preceding preliminary tests, the experimentation was extended to include other kinds of sprays, which were tried out in the pineapple fields of the Philippine Packing Corporation at Santa Fe, Bukidnon Province, in February, 1930.

Materials and methods.—Bordeaux mixture, lime-sulphur, copper sulphate, mercuric chloride, and Semesan were compared in this experiment. Weekly application was made on Hawaiian Smooth Cayenne plants in bloom in field 1 of double rows spaced at 56 by 22 by 18 inches, for a duration of about two

TABLE 2.—*Results of lime-sulphur spray vs. Bordeaux-mixture spray for the control of bacterial fruitlet rots.*

Rows.		Spray solution.	Concentration.	Frequency of application.	Fruits observed.	Average weight.	Pathologic observations.				Efficacy of control.
							Healthy.	Slightly infected.	Severely infected.	Total loss.	
						Kg.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
A	1- 4	Bordeaux mixture	3-3-50	Triweekly	1,245	2.13	94.4	5.6	Nil.	Nil.	82.8
	5- 8	Check (not sprayed)			1,440	2.28	67.3	29.6	2.8	0.3	
	9-12	Lime-sulphur (33° B.)	1:70	Triweekly	1,335	2.10	88.7	11.3	Nil.	Nil.	65.4
B	1- 4	Bordeaux mixture	3-2-50	Biweekly	1,490	2.25	95.1	4.9	Nil.	Nil.	70.8
	5- 8	Check (not sprayed)			1,814	2.26	83.2	14.8	1.3	0.7	
	9-12	Lime-sulphur (33° B.)	1:80	Biweekly	1,586	2.25	94.9	5.1	Nil.	Nil.	69.6
C	1- 4	Bordeaux mixture	3-4-50	do.	1,350	2.50	90.3	9.1	0.6	Nil.	79.1
	5- 8	Check (not sprayed)			1,352	2.40	62.2	23.1	11.1	3.6	
	9-12	Lime-sulphur (33° B.)	1:70	Biweekly	1,293	2.40	84.5	12.4	3.1	Nil.	59.0

months beginning February, 1930. Rows 1 to 3 were sprayed with a 3–4–50 solution of Bordeaux mixture, and rows 4 to 6 with a 4–5–50 solution; rows 7 to 9 were treated with 1 : 70 lime-sulphur (33° Baumé), leaving rows 10 to 12 unsprayed as check. Rows 13 to 15 were sprayed with a 1 : 1,000 solution of copper sulphate, rows 16 to 18 with a 1 : 1,500 solution, and rows 19 to 21 with a 1: 2,000 solution, leaving rows 22 to 24 unsprayed as check. Rows 25 to 27 were sprayed with a 1: 3,000 solution of mercuric chloride, rows 28 to 30 with a 1: 4,000 solution, and rows 31 to 33 with a 1: 5,000 solution, leaving rows 34 to 36 unsprayed as check. Rows 37 to 39 were sprayed with a 1: 200 solution of Semesan, rows 40 to 42 with a 1: 300 solution, and rows 43 to 45 with a 1: 400 solution, leaving rows 46 to 48 unsprayed as check. In every case spraying was done with thoroughness so as to insure uniform and complete covering of the flowers and young fruitlets composing the fruit with the spray material, a condition upon which the efficacy of the treatment greatly depends.

Results.—As soon as signs of ripening were noticed, all fruits in the experiment were picked separately by the row and each individual fruit cross-cut into slices 1 to 2 centimeters thick for pathologic observations. The results of such examinations are shown in Table 3.

Table 3 shows that none of the other sprays tried compare favorably in efficiency with Bordeaux mixture for the control of the bacterial fruitlet rots. It further shows that Bordeaux mixture of the 4–5–50 formula is more effective than the less-concentrated 3–4–50 formula. Because of the stunting effects on the fruits caused by the stronger solution as demonstrated by the reduced weights, such advantage in efficacy over the less-concentrated solution is, nevertheless, dubious and needs further elucidation.

That Bordeaux mixture turned out to be the most effective of the sprays tried may be explained, perhaps, by the fact that it furnishes the best "coating material" in the form of a colloidal precipitate, copper hydroxide [$Cu(OH)_2$], which covers the surface of the fruit quite well, protecting it from the pathogens. This colloidal precipitate is said to possess the fungicidal properties of the mixture.

EXPERIMENT 4

Having more or less ascertained that Bordeaux mixture of a concentration between 3–4–50 and 4–5–50 is the best spray tried

TABLE 3.—*Results of weekly spraying with Bordeaux mixture, lime-sulphur, copper sulphate, mercuric chloride, and Semesan, for the control of bacterial fruitlet rots.*

Rows.	Spray solution.	Concentration.	Fruits observed.[a]	Average weight.	Pathologic observations.				Efficacy of control.
					Healthy.	Slightly infected.	Severely infected.	Total loss.	
				Kg.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1– 3	Bordeaux mixture	3-4-50	350	2.5	90.3	9.1	0.6	Nil.	79.1
4– 6	Do.	4-5-50	334	2.2	93.3	6.3	0.4	Nil.	82.3
7– 9	Lime sulphur (33° B.)	1:70	293	2.4	84.5	12.4	3.1	Nil.	59.0
10–12	Check (not sprayed)		352	2.4	62.2	23.1	11.1	3.6	
13–15	Copper sulphate	1:1,000	332	2.3	72.0	17.0	8.1	2.9	22.2
16–18	Do.	1:1,500	313	2.3	74.9	14.7	8.4	2.0	30.3
19–21	Do.	1:2,000	320	2.4	78.8	11.4	9.1	0.7	41.1
22–24	Check (not sprayed)		369	2.4	64.0	17.0	15.3	3.7	
25–27	Mercuric chloride	1:3,000	350	2.2	72.4	16.3	10.2	1.1	38.2
28–30	Do.	1:4,000	299	2.2	78.8	11.9	8.0	1.3	52.5
31–33	Do.	1:5,000	282	2.4	76.4	11.8	10.6	1.2	47.2
34–36	Check (not sprayed)		238	2.5	55.3	18.2	16.7	9.8	
37–39	Semesan	1:200	212	2.4	70.2	18.2	11.5	0.1	5.1
40–42	Do.	1:300	232	2.3	76.4	14.3	8.7	0.6	24.8
43–45	Do.	1:400	262	2.4	69.2	16.7	11.6	2.5	1.9
46–48	Check (not sprayed)		216	2.5	68.6	15.0	12.8	3.6	

[a] On account of the prevalence of mealy-bug wilt only about one-third of the plants developed to maturity, hence the small number of fruits observed.

for the control of bacterial fruitlet rots, followed by lime-sulphur (33° Baumé) at 1: 70 to 1: 80 dilutions, the next step was to determine the time and frequency of application so as to attain the best results. For this purpose an experiment was undertaken in field 1 of the Philippine Packing Corporation at Santa Fe, Bukidnon Province, in March, 1930.

Materials and methods.—Flowering Smooth Cayenne pineapples grown from Hawaiian plant material were used in this experiment, which consisted of three series. In the first series spraying was done monthly for one, two, three, and four consecutive months, while in the second and third series the application was made fortnightly, also for one, two, three, and four consecutive months. For the first and second series Bordeaux mixture of the formula 3–4–50 was employed during the first month when the fruitlets were still tender and susceptible to scorching; but beginning with the second month when the flowers were already dry, a stronger solution of the formula, 4–5–50, was used till the end. For the third series, fresh lime-sulphur (33° Baumé) at 1: 80 and 1: 70 dilution was used. Because of frequent rains in Santa Fe and in Bukidnon Province as a whole, in all cases resin-sal-soda sticker was added to the solution at the rate of 1: 50. As an additional precaution spraying was done in the morning, for rain usually occurs in the afternoon. Whenever there was rain during the day, spraying was postponed to a later date.

Results.—As soon as signs of ripening were noticed, the fruits were picked separately by the row, then sent to the factory where all the necessary pathologic observations were made. The results are shown in Table 4.

Table 4 shows, first, that of Bordeaux mixture and lime-sulphur the former proved still the better spray for the control of bacterial fruitlet rots; second, that fortnightly application is more effective than monthly application; third, that spraying fortnightly for three to four months from the time the flowers open is necessary to reduce the infections to the minimum, particularly severe infection; fourth, that neither Bordeaux mixture of 4–5–50 formula nor lime-sulphur (33° Baumé) at 1 : 70 dilution cause any scorching or stunting as revealed by the uniform weights of the fruits of both the treated and the control, if applied following the more dilute solutions, or beginning the second month when the flowers have dried up; and lastly, that lime-sulphur is almost as effective as Bordeaux mixture if the spray is

TABLE 4.—*Results of monthly and fortnightly applications of Bordeaux-mixture and lime-sulphur spray for the control of bacterial fruitlet rots.*

Rows.	Spray solution.	Concentration.		Dates of application.	Fruits observed.	Average weight.	Pathologic observations.				Efficacy of control.
		First month.	Last 3 months.				Healthy.	Slightly infected.	Severely infected.	Total loss.	
				1930		*Kg.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1– 3	Bordeaux mixture	3-4-50	4-5-50	Mar. 1	395	2.5	75.0	17.5	6.5	1.0	33.1
4– 6	Do.	3-4-50	4-5-50	Mar. 1; Apr. 1	406	2.4	84.5	10.5	4.3	0.7	58.5
7– 9	Do.	3-4-50	4-5-50	Mar. 1; Apr. 1; May 1	362	2.5	89.7	7.0	3.3	Nil.	72.4
10–12	Do.	3-4-50	4-5-50	Mar. 1; Apr. 1; May 1; June 1	387	2.4	93.0	4.4	2.6	Nil.	81.3
13–15	Check (not sprayed)				374	2.4	62.6	23.5	11.2	2.7	
16–18	Bordeaux mixture	3-4-50	4-5-50	Mar. 1 and 15	411	2.5	85.0	10.5	4.0	0.5	60.9
19–21	Do.	3-4-50	4-5-50	Mar. 1 and 15; Apr. 1 and 15	423	2.4	90.3	7.0	2.5	0.2	74.7
22–24	Do.	3-4-50	4-5-50	Mar. 1 and 15; Apr. 1 and 15; May 1 and 15.	388	2.4	97.7	2.3	Nil.	Nil.	94.0
25–27	Do.	3-4-50	4-5-50	Mar. 1 and 15; Apr. 1 and 15; May 1 and 15; June 1 and 15.	401	2.5	98.0	2.0	Nil.	Nil.	94.7
28–30	Check (not sprayed)				390	2.4	61.6	24.3	10.3	3.8	
31–33	Lime-sulphur (33° B.)	1:80	1:70	Mar. 1 and 15	398	2.5	84.5	10.7	4.3	0.5	56.3
34–36	Do.	1:80	1:70	Mar. 1 and 15; Apr. 1 and 15	420	2.4	90.2	7.5	2.0	0.3	72.4
37–39	Do.	1:80	1:70	Mar. 1 and 15; Apr. 1 and 15; May 1 and 15.	385	2.5	96.6	3.4	Nil.	Nil.	90.4
40–42	Do.	1:80	1:70	Mar. 1 and 15; Apr. 1 and 15; May 1 and 15; June 1 and 15.	400	2.4	97.0	3.0	Nil.	Nil.	91.5
43–45	Check (not sprayed)				393	2.5	64.5	24.9	8.6	2.0	

obtained from a newly prepared stock solution. Lime-sulphur solution seems to degenerate somewhat with age, as shown by a comparison of the efficiency in Tables 1 and 4 with that in Tables 2 and 3. It should be remembered that the lime-sulphur used for experiments 1 and 4 was obtained from a newly prepared stock solution, while that employed for experiments 2 and 3 was made from an old stock solution. This finding confirms the traditional view that nothing but freshly prepared spray solution should be used, if the highest efficacy of control is desired. This is especially true of Bordeaux mixture. Rightly mixed and freshly made, Bordeaux mixture is remarkably adhesive and does not yield easily to the washing action of rains.

SHADING

As the temperature requirements of the causal bacteria are rather high,(14, 15) it was assumed that shading the fruits from the direct heat of the sun might help to minimize the ravages resulting from bacterial fruitlet rots.

EXPERIMENT 5

At the suggestion of Mr. H. A. White, president of the Philippine Packing Corporation, a shading experiment was carried out at Calauan, Laguna Province, in January, 1927, for the purpose of determining the possible adverse effect of shading on the incidence and development of the infection.

Materials and methods.—Just before the flowering season commenced, two bamboo frames about 60 meters long, 3 meters wide, and 2 meters high were erected over a plot consisting of fourteen rows of sixty Smooth Cayenne plants each, spaced 1 meter by 1 meter each way, the first frame covering rows 3 to 5 and the second, rows 10 to 12. On top of each of the frames dry coco-palm leaves were placed crosswise in such a way as to furnish more or less uniform shading throughout, as shown in Plate 1, fig. 2.

Results.—The fruits, when ripe, were picked by the row and those of rows 1, 7, 8, and 14 grouped together as unshaded fruits; those of rows 3, 5, 10, and 12 as partially shaded fruits; those of rows 4 and 11 as well-shaded fruits. Those of rows 2, 6, 9, and 13 were discarded as undesirable. The fruits were then brought to the laboratory at the Bureau of Science in Manila for pathologic examination and other necessary pertinent data as shown in Tables 5 and 6.

TABLE 5.—*Adverse effects of shading on bacterial fruitlet rots.*

Treatment.	Fruits observed.	Pathologic observations.				Efficacy of control.
		Healthy.	Slightly infected.	Severely infected.	Total loss.	
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Unshaded	108	66.7	21.9	9.8	1.6	----------
Partially shaded	114	71.2	22.6	5.4	0.8	13.5
Well shaded	59	76.2	18.7	5.1	Nil.	28.5

It is shown in Table 5 that shading reduces the damage caused by the bacterial fruitlet rots, the beneficial effect being evident not so much in the decrease of the total percentage of infection as in the increased percentage of fruits good for canning. It would seem that shading does not prevent bacterial fruitlet-rot infections, but it creates a condition rather unfavorable for their progress.

To determine what that condition is, separate samples of both the exposed and the shaded fruits were submitted to the organic chemistry division of the Bureau of Science for analysis; then a comparison was made between the daily temperature of the exposed and the shaded fruits on the one hand, and the daily temperature of the exposed atmosphere and shaded atmosphere on the other. The procedure was as follows: A mercury thermometer was thrust 15 centimeters deep into each of two mature Smooth Cayenne fruits, one exposed and the other shaded; a third thermometer was suspended in the air 75 centimeters above the soil near the exposed fruit; the readings of each thermometer were taken every two hours from 6 a. m. to 6 p. m. for three months; the fourth, which is a self-recording hygrothermograph, was placed under a shed with free circulation of air. The results are shown in Table 6 and in text fig. 1.

TABLE 6.—*Comparative analyses of exposed fruits and shaded fruits.*

Fruits.	Brix of jurice corrected to 27.5°C.	pH value.	Protein.	Sugars.		
				Sucrose.	Reducing.	Total as invert.
	Per cent.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Exposed	14.39	4.37	0.39	7.82	3.97	12.19
Shaded	14.40	4.37	0.40	7.66	4.31	12.37

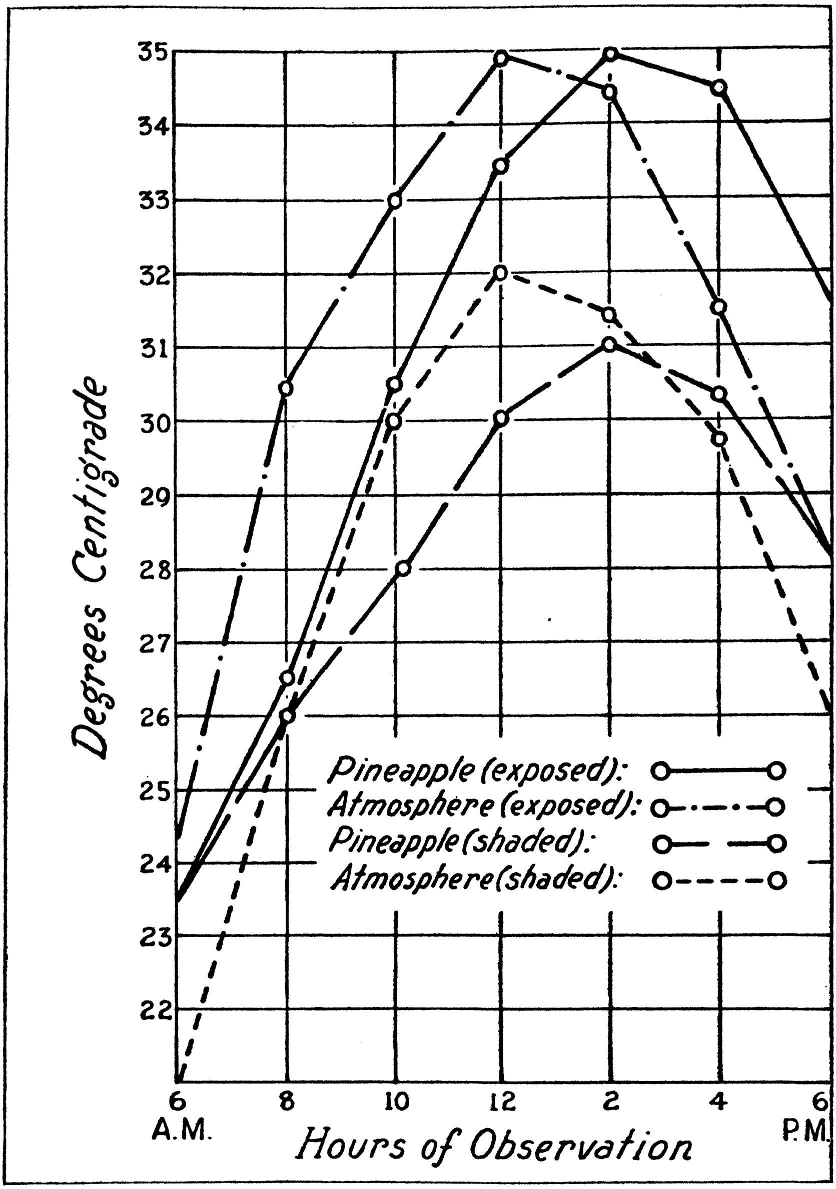

FIG. 1. Showing temperature relations from 6 a. m. to 6 p. m. between atmosphere and pineapple, both shaded and exposed.

Table 6 shows that shading has not changed the composition of the fruits so much as materially to affect the activities of the bacterial pathogens responsible for the fruitlet rots one way or another. On the other hand text fig. 1 shows that the tem-

perature of the exposed air is about 3° C. higher than that of the shaded air, and that the temperature of the exposed fruit is correspondingly higher by about 4° C. than that of the shaded fruit. In view of the fact that both *Erwinia ananas* Serrano (14) and *Phytomonas ananas* Serrano, (15) causing the pineapple fruitlet rots, require a fairly high temperature for optimum growth, the low average atmospheric temperature under shade which necessarily lowers the temperature of the shaded fruits, may well explain the marked reduction in the severity of the bacterial fruitlet rots among the shaded pineapple fruits, and also the observations of pineapple growers that fruit-rot infections are worst following protracted hot weather.

EXPERIMENT 6

Because of the encouraging results obtained from the preliminary experiments on shading, further trials were carried out with different types of sheds. Experiment 6 was performed in May, 1930, in field 1 of the Philippine Packing Corporation at Santa Fe, Bukidnon Province.

Materials and methods.—The experimental block with Smooth Cayenne fruits adjudged to mature in two to three months was divided into five sections of ten double rows each. The first five rows of each of three sections were shaded with cogon grass [*Imperata cylindrica* (Linn.) Beauv.] in three different ways; first, by putting a cogon-grass ring closely around the fruit; second, by spreading a cogon-grass bundle top down over the fruit; third, by spreading a cogon-grass layer over the fruit, leaving every second five rows unshaded as check. The fourth section was shaded by placing a bagokbok-grass ring (*Apluda mutica* Linn.) around each fruit of the first five rows, while the fifth was shaded by tying the pineapple leaves together over the fruits of the first five rows, leaving the fruits of the intervening ten rows unshaded as check. At harvest the fruits were grouped according to type of shading, and sent to the factory where the necessary observations were made. The results are shown in Table 7.

About two to three weeks prior to the ripening of the fruits a comparison of the relative temperatures of the fruits under the last four treatments was made by thrusting one mercury thermometer 15 centimeter deep into each of two fruits under each treatment, one on the side facing east and the other on the side facing west, taking the readings every day at 6 a. m., 12 noon, and 6 p. m., for a week. The results are included in Table 7.

TABLE 7.—*The effect of shading on the prevalence of bacterial fruitlet rots and on the color of the fruits.*

Type of shading.	Temperature of the fruits.	Fruits observed.	Pathologic observations.			
			Healthy.	Slightly infected.	Severely infected.	Total loss.
	°*F.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cogon ring	----------	669	83.9	12.2	3.2	0.7
Cogon bundle	----------	629	87.3	10.4	1.7	0.6
Cogon layer	77.3	1,166	88.2	10.2	1.5	0.1
Bagokbok ring	77.1	1,354	90.3	8.0	1.7	Nil.
Tying leaves	79.0	854	84.6	13.2	1.9	0.3
Check	79.6	1,127	72.2	23.7	3.3	0.8

Type of shading.	Color of pulp.		Efficacy of control.
	Yellow.	White.	
	Per cent.	*Per cent.*	*Per cent.*
Cogon ring	51.1	48.9	42.1
Cogon bundle	40.5	59.5	54.3
Cogon layer	29.7	70.3	57.5
Bagokbok ring	38.1	61.9	65.1
Tying leaves	51.9	48.1	44.6
Check	52.2	47.8	----------

Table 7 shows that of the different types of shading tried the bagokbok ring gave the highest efficacy of control, or 65.1 per cent, followed by the cogon layer, with 57.5 per cent. These high efficacy ratings are associated with correspondingly high reduction in daily fruit temperature, indicating the adverse effect of low temperature on the pathogens. This result is not entirely satisfactory, however. In the first place, it is about 30 per cent less than the efficacy of either Bordeaux-mixture spray or lime-sulphur spray; and in the second place, shading seems to cause discoloration of the fruits, reducing the number of fruits with yellow pulp by about 10 per cent. This effect is the reverse of that of spraying which, according to actual observation, improves the color of the fruits treated. Therefore, for the control of the bacterial fruitlet rots shading has proved to be inferior to spraying.

FERTILIZER APPLICATION

As early as 1863 crop investigators found that oftentimes the application of fertilizer resulted in either decreasing or aggravating the diseases of plants. In order to determine what effects,

if any, fertilizer application would have on the prevalence of the pineapple bacterial fruitlet rots under Bukidnon conditions, the following experiment was conducted.

EXPERIMENT 7

Experiment 7 was begun July 1, 1929, in field 1 of the Philippine Packing Corporation, in Bukidnon, which was planted in January of the same year to Smooth Cayenne planting material imported from Hawaii.

Materials and methods.—The block chosen for this trial was the best in the whole Hawaiian Smooth Cayenne field, although the stand was not as uniform as could have been desired, owing to the presence of mealy-bug wilt, which required several replantings. Six chemical fertilizers were tried, and each was applied in three different amounts per hectare, in one, two, and three replenishments at quarterly intervals. The fertilizer was strewn by hand over the bases of the plants along both sides of the row, and then covered by hoeing the dirt in. Every other three rows were left untreated, the interjacent remaining as check and the two adjacent as blanket rows. The planting plan of the entire experiment is given in Table 8.

TABLE 8.—*The arrangement of fertilizer-plot experiment.*

[N, Ammonium sulphate, 20.4 per cent; P, superphosphate (acid phosphate) 20.4 per cent; K, potassium sulphate, 49.6 per cent; NP, Ammo-Phos, 20–20; NPK, Corona No. 1, 10–6–2; N-P-K, Filfer, 17–10–3.5.]

Row.	Treatment.	Months of application.	Row.	Treatment.	Months of application.
	Kg. per ha.			*Kg. per ha.*	
1	N, 500	7th, 10th, and 13th.	19	N, 500	7th and 13th.
2	N, 1,000	Do.	20	N, 1,000	Do.
3	N, 1,500	Do.	21	N, 1,500	Do.
4	Blanket		22	Blanket	
5	Check		23	Check	
6	Blanket		24	Blanket	
7	N, 500	7th and 10th.	25	N, 500	7th.
8	N, 1,000	Do.	26	N, 1,000	Do.
9	N, 1,500	Do.	27	N, 1,500	Do.
10	Blanket		28	Blanket	
11	Check		29	Check	
12	Blanket		30	Blanket	
13	N, 500	10th and 13th.	31	N, 500	10th.
14	N, 1,000	Do.	32	N, 1,000	Do.
15	N, 1,500	Do.	33	N, 1,500	Do.
16	Blanket		34	Blanket	
17	Check		35	Check	
18	Blanket		36	Blanket	

TABLE 8.—*The arrangement of fertilizer-plot experiment*—Continued.

[N, Ammonium sulphate, 20.4 per cent; P, superphosphate (acid phosphate) 20.4 per cent; K, potassium sulphate, 49.6 per cent; NP, Ammo-Phos, 20–20; NPK, Corona No. 1, 10–6–2; N-P-K, Filfer, 17–10–3.5.]

Row.	Treatment.	Months of application.	Row.	Treatment.	Months of application.
	Kg. per ha.			*Kg. per ha.*	
37	N, 500	13th.	85	K, 200	7th, 10th, and 13th.
38	N, 1,000	Do.	86	K, 500	Do.
39	N, 1,500	Do.	87	K, 1,000	Do.
40	Blanket		88	Blanket	
41	Check		89	Check	
42	Blanket		90	Blanket	
43	P, 500	7th, 10th, and 13th.	91	K, 200	7th and 10th.
44	P, 1,000	Do.	92	K, 500	Do.
45	P, 1,500	Do.	93	K, 1,000	Do.
46	Blanket		94	Blanket	
47	Check		95	Check	
48	Blanket		96	Blanket	
49	P, 500	7th and 10th.	97	K, 200	10th and 13th.
50	P, 1,000	Do.	98	K, 500	Do.
51	P, 1,500	Do.	99	K, 1,000	Do.
52	Blanket		100	Blanket	
53	Check		101	Check	
54	Blanket		102	Blanket	
55	P, 500	10th and 13th.	103	K, 200	7th and 13th.
56	P, 1,000	Do.	104	K, 500	Do.
57	P, 1,500	Do.	105	K, 1,000	Do.
58	Blanket		106	Blanket	
59	Check		107	Check	
60	Blanket		108	Blanket	
61	P, 500	7th and 13th.	109	K, 200	7th.
62	P, 1,000	Do.	110	K, 500	Do.
63	P, 1,500	Do.	111	K, 1,000	Do.
64	Blanket		112	Blanket	
65	Check		113	Check	
66	Blanket		114	Blanket	
67	P, 500	7th.	115	K, 200	10th.
68	P, 1,000	Do.	116	K, 500	Do.
69	P, 1,500	Do.	117	K, 1,000	Do.
70	Blanket		118	Blanket	
71	Check		119	Check	
72	Blanket		120	Blanket	
73	P, 500	10th.	121	K, 200	13th.
74	P, 1,000	Do.	122	K, 500	Do.
75	P, 1,500	Do.	123	K, 1,000	Do.
76	Blanket		124	Blanket	
77	Check		125	Check	
78	Blanket		126	Blanket	
79	P, 500	13th.	127	NP, 500	7th, 10th, and 13th.
80	P, 1,000	Do.	128	NP, 1,000	Do.
81	P, 1,500	Do.	129	NP, 1,500	Do.
82	Blanket		130	Blanket	
83	Check		131	Check	
84	Blanket		132	Blanket	

TABLE 8.—*The arrangement of fertilizer-plot experiment*—Continued.

[N, Ammonium sulphate, 20.4 per cent; P, superphosphate (acid phosphate) 20.4 per cent; K, potassium sulphate, 49.6 per cent; NP, Ammo-Phos, 20–20; NPK, Corona No. 1, 10–6–2; N-P-K, Filfer, 17–10–3.5.]

Row.	Treatment.	Months of application.	Row.	Treatment.	Months of application.
	Kg. per ha.			*Kg. per ha.*	
133	NP, 500	7th and 10th.	181	NPK, 500	10th and 13th.
134	NP, 1,000	Do.	182	NPK, 1,000	Do.
135	NP, 1,500	Do.	183	NPK, 1,500	Do.
136	Blanket		184	Blanket	
137	Check		185	Check	
138	Blanket		186	Blanket	
139	NP, 500	10th and 13th.	187	NPK, 500	7th and 13th.
140	NP, 1,000	Do.	188	NPK, 1,000	Do.
141	NP, 1,500	Do.	189	NPK, 1,500	Do.
142	Blanket		190	Blanket	
143	Check		191	Check	
144	Blanket		192	Blanket	
145	NP, 500	7th and 13th.	193	NPK, 500	7th.
146	NP, 1,000	Do.	194	NPK, 1,000	Do.
147	NP, 1,500	Do.	195	NPK, 1,500	Do.
148	Blanket		196	Blanket	
149	Check		197	Check	
150	Blanket		198	Blanket	
151	NP, 500	7th.	199	NPK, 500	10th.
152	NP, 1,000	Do.	200	NPK, 1,000	Do.
153	NP, 1,500	Do.	201	NPK, 1,500	Do.
154	Blanket		202	Blanket	
155	Check		203	Check	
156	Blanket		204	Blanket	
157	NP, 500	10th.	205	NPK, 500	13th.
158	NP, 1,000	Do.	206	NPK, 1,000	Do.
159	NP, 1,500	Do.	207	NPK, 1,500	Do.
160	Blanket		208	Blanket	
161	Check		209	Check	
162	Blanket		210	Blanket	
163	NP, 500	13th.	211	N-P-K, 500	7th, 10th, and 13th.
164	NP, 1,000	Do.	212	N-P-K, 1,000	Do.
165	NP, 1,500	Do.	213	N-P-K, 1,500	Do.
166	Blanket		214	Blanket	
167	Check		215	Check	
168	Blanket		216	Blanket	
169	NPK, 500	7th, 10th, and 13th.	217	N-P-K, 500	7th and 10th.
170	NPK, 1,000	Do.	218	N-P-K, 1,000	Do.
171	NPK, 1,500	Do.	219	N-P-K, 1,500	Do.
172	Blanket		220	Blanket	
173	Check		221	Check	
174	Blanket		222	Blanket	
175	NPK, 500	7th and 10th.	223	N-P-K, 500	10th and 13th.
176	NPK, 1,000	Do.	224	N-P-K, 1,000	Do.
177	NPK, 1,500	Do.	225	N-P-K, 1,500	Do.
178	Blanket		226	Blanket	
179	Check		227	Check	
180	Blanket		228	Blanket	

TABLE 8.—*The arrangement of fertilizer-plot experiment*—Continued.

[N, Ammonium sulphate, 20.4 per cent; P, superphosphate, (acid phosphate) 20.4 per cent; K, potassium sulphate, 49.6 per cent; NP, Ammo-Phos, 20–20; NPK, Corona No. 1, 10–6–2; N-P-K, Filfer, 17–10–3.5.]

Row.	Treatment.	Months of application.	Row.	Treatment.	Months of application.
	Kg. per ha.			*Kg. per ha.*	
229	N-P-K, 500	7th and 13th.	241	N-P-K, 500	10th.
230	N-P-K, 1,000	Do.	242	N-P-K, 1,000	Do.
231	N-P-K, 1,500	Do.	243	N-P-K, 1,500	Do.
232	Blanket		244	Blanket	
233	Check		245	Check	
234	Blanket		246	Blanket	
235	N-P-K, 500	7th.	247	N-P-K, 500	13th.
236	N-P-K, 1,000	Do.	248	N-P-K, 1,000	Do.
237	N-P-K, 1,500	Do.	249	N-P-K, 1,500	Do.
238	Blanket		250	Blanket	
239	Check		251	Check	
240	Blanket		252	Blanket	

Results.—All fruits, upon ripening, were picked by the row, weighed, and taken to the factory for the necessary observations, such as acidity in terms of pH value, pathologic infections, and color of pulp; the results are shown in Table 9. Every fertilizer used is represented in this table only by the row giving the best results in so far as increasing the tonnage production and reducing the bacterial fruitlet-rot infections are concerned.

Table 9 shows, first of all, a 0.2-kilo increase in the average weight per fruit of row 32, fertilized once with ammonium sulphate at the rate of 1,000 kilos per hectare the tenth month; of row 98, fertilized with potassium sulphate at the rate of 500 kilos per hectare, in two equal replenishments the tenth and thirteenth months; of row 141, fertilized with Ammo-Phos at the rate of 1,500 kilos per hectare, in two equal replenishments the tenth and thirteenth months; of row 183, fertilized with Corona No. 1 at the rate of 1,500 kilos per hectare, in two equal replenishments the tenth and thirteenth months; and of row 224, fertilized with Filfer at the rate of 1,000 kilos per hectare, also in two equal replenishments the tenth and thirteenth months. It seems quite evident that under the conditions obtaining in field 1, Santa Fe, Bukidnon Province, fertilizer application with ammonium sulphate, potassium sulphate, or any other complete fertilizer at the rate given above would be most beneficial to Smooth Cayenne when applied in two equal replenishments during the tenth and thirteenth months. This would seem to indicate that the bulk of the essential elements

TABLE 9.—*The effects of fertilizers on Smooth Cayenne fruits with special reference to the prevalence of bacterial fruitlet-rot infections.*

Row.	Fertilizer.	Composition. N	Composition. P_2O_5	Composition. K_2O	Rate of application.	Fruits observed.	Average weight.	Color of pulp. Yellow.	Color of pulp. White.
					Kg. per ha.		*Kg.*	*Per cent.*	*Per cent.*
32	Ammonium sulphate	20.6	0	0	1,000	308	2.4	60.5	39.5
49	Phosphate, acid	0	20.4	0	500	274	2.2	66.7	33.3
98	Potassium sulphate	0	0	49.6	500	306	2.4	65.0	35.0
141	Ammo-Phos	20.0	20.0	0	1,500	280	2.4	74.2	25.8
183	Corona No. 1	10.0	6.0	2.0	1,500	292	2.4	67.7	32.3
224	Filfer	17.0	10.0	3.5	1,000	318	2.4	73.9	26.1
([b])	Checks (not fertilized)	0	0	0	0	297	2.2	52.2	47.8

Row.	Fertilizer.	pH value[a] (acidity). Healthy.	pH value[a] (acidity). Diseased.	Pathologic observations. Healthy.	Pathologic observations. Slightly infected.	Pathologic observations. Severely infected.	Pathologic observations. Total loss.	Efficacy of control.
				Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
32	Ammonium sulphate	3.9	4.4	79.9	12.0	6.3	1.8	6.5
49	Phosphate, acid	3.9	4.3	80.4	15.7	3.7	0.2	8.8
98	Potassium sulphate	3.8	4.3	94.5	5.4	0.1	Nil.	74.4
141	Ammo-Phos	3.9	4.5	81.6	12.8	5.3	0.3	14.4
183	Corona No. 1	3.8	4.3	90.6	8.4	0.9	0.1	56.2
224	Filfer	3.9	4.2	83.9	9.3	6.4	0.4	25.1
([b])	Checks (not fertilized)	4.0	4.5	78.5	16.6	4.7	0.2	----------

[a] The pH values were determined by colorimetric method with La Motte's apparatus. Each composite sample was prepared by extracting separately fresh juice of ten uniform ripe fruits, either healthy or diseased.

[b] Rows 35, 53, 101, 143, 185, and 227 are the checks.

for pineapple-fruit development are most needed after the plants have fully developed vegetatively and are ready for the elaborate transformation incidental to sexual development.

Table 9 further shows that treatment with any one of the commercial fertilizers tried improves the color of the fruit pulp, increasing the number of rich yellow fruits from about 6 to 26 per cent.

Of all the benefits derived from the fertilizer treatments, disease control as demonstrated by potassium sulphate is, perhaps, the most important, at least from the standpoint of the plant pathologist. Potash application in the form of potassium sulphate caused a reduction in total infection by about 75 per cent, at the same time rendering the treated fruits all good for canning. These positive results seem to confirm the reports of Marchal,(8) Spinks,(17) Russell,(13) Finlow,(4) and Butler,(2) to the effect that potash application minimizes the incidence of plant diseases. On the other hand, ammonium sulphate increased the number of fruits unfit for canning or severely infected, by more than 3 per cent, and caused no appreciable reduction in the total infections, while phosphorus in the form of acid phosphate showed very little beneficial effect. As was to be expected, a combination of ammonium sulphate and acid phosphate showed a better result than ammonium sulphate alone. It appears, therefore, that the reduced amount of infection obtained from the treatment with Corona No. 1 and with Filfer were mainly due to the potash content of these fertilizers. It may be deduced further that Corona No. 1 showed superiority over Filfer in effecting a partial control of bacterial fruitlet rots, because of the fact that Filfer contains almost twice as much nitrogen as Corona No. 1, and nitrogen is a fertilizer ingredient that Sheldon,(16) Peltier,(11) Liebig,(6) Roberts,(12) Laurent,(5) Marchal,(8) Delacroix,(3) McAlpine,(9) Spinks,(17) McCue and Pelton,(10) Butler,(2) and Thomas,(18) found to be a predisposing cause of plant diseases, or to favor their occurrence, on the assumption that the succulence of the tissues caused by it facilitates parasitic invasion.

How potash and to some extent phosphorus increased the resistance of pineapple fruits to bacterial fruitlet-rot infections is not clearly known. It would seem that the increased acidity of the fruits treated singly with potassium sulphate (pH 3.8) and in combination with other fertilizing ingredients (pH 3.9), and

those treated with other fertilizers minus potash (pH 3.9) over the check (pH 4), is due to the inhibitive influence of the acid. In accordance with, and in support of, this view are the results obtained by the writer (14,15) from the cultural studies made on the acid requirements of the bacterial fruitlet-rot pathogens, showing that an acidity of pH 3.8 is almost prohibitive for their growth. This is perchance the reason why in Hawaii, where the acidity of pineapple fruits ranges from pH 3.6 to pH 3.8, the bacterial fruitlet-rot diseases are very mild. These findings would seem to find further support in the reports of earlier investigators like Delacroix,(3) who suggested that phosphate inhibits disease by increasing the acidity of cell sap; Bishop,(1) and Tracy,(19) who stated that potash application increases the acidity of tomato fruits; Truog,(20) and Truog and Meacham,(21) who, in interpreting the results of their experiments, advanced the opinion that the acidity of the plant sap can be modified by the acidity of the soil. There is, therefore, a strong indication that the relative acidity of the fruit is a controlling factor in the incidence and seriousness of bacterial fruitlet rots of pineapple.

Another factor, which perhaps contributed disease resistance to the pineapple fruits treated with potash, is the firmness of the tissues resulting from the treatment. It had been observed that fruits from the potash-treated lots were firmer and less succulent than the control, and particularly so compared with those treated with ammonium sulphate and Ammo-Phos. It would appear, therefore, that the firmer and the less succulent the fruits are, the less susceptible they become to parasitic invasions.

BREEDING AND SELECTION FOR IMMUNITY

Just as breeding and selection of the most desirable plants for seed are essential to increase yield, so also are breeding and selection for resistance or immunity to control plant diseases and pests. The genetics department of the Experiment Station of the Association of Hawaiian Pineapple Canners has recently produced a pineapple hybrid, by crossing Smooth Cayenne with a Brazilian wild pineapple, possessed of great vigor of plant and root growth, nematode resistance, high-sugar and high-acid content. In the light of these findings the results obtained from the following preliminary experiments become quite significant.

EXPERIMENT 8: MASS SELECTION I

The writer (14, 15) has reported that approximately 22 to 27 per cent of the pineapple fruits in his experiments were not infected at all, even after they had been sprayed heavily with water suspension of the bacterial pathogens during their development. In view of this phenomenon mass selection of apparently resistant plants was considered full of promise in at least minimizing the ravages of the infections, and an experiment to determine the possibilities of such a method was undertaken beginning the middle of 1928.

Materials and methods.—Two thousand one hundred fruited Smooth Cayenne plants in the trial plots belonging to the Philippine Packing Corporation at Santa Fe, Bukidnon Province, were numbered consecutively from 1 to 2,100 in quadruplicates, the first two numbers being placed on each of two leaflets of the crown and the other two on each of two conspicuous leaves of the plant. To make sure that a representative group was covered, plants with fruits of varied sizes and stages of development were selected. As soon as signs of ripening were noticed the fruits were picked and each cross-cut into slices 1 to 2 centimeters thick for bacterial fruitlet-rot observation; crowns of infected fruits were placed in one pile and crowns of healthy fruits in another. The corresponding slips and suckers were gathered with care and separated likewise. After proper curing and trimming they were planted separately in two general groups as "healthy stock" and "diseased stock" and arranged in rows of suckers, slips, and crowns, at a standard spacing of 56 by 22 by 18 inches (approximately 1.39 by 0.56 by 0.46 meter).

Results.—About the middle of 1929 the ratoon crop of the numbered plants was picked and, following the data on first plant crop observations, grouped as "healthy stock" and "diseased stock," and each fruit cross-cut later into slices 1 to 2 centimeters thick and examined for bacterial fruitlet-rot infection. In the following year (1930) the plant crops of both healthy stock and diseased stock were picked by the group as they ripened, and the necessary pathologic observations made as before. All pertinent data gathered from the beginning of the experiment are shown in text fig. 2, together with pathologic observations on fruits from unselected plants maturing at the same time, as check.

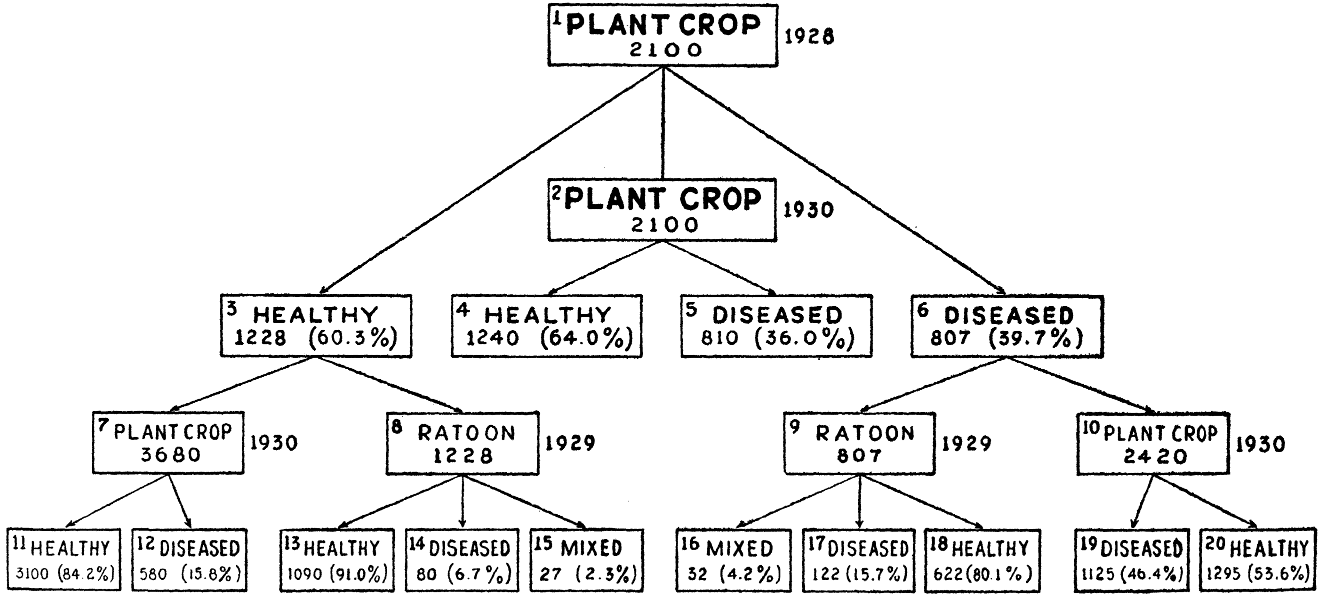

FIGURE 2. *Diagram showing possible beneficial effect of plant selection in reducing bacterial fruitlet rot infections.*
LEGENDS: *1 = plant crop, unselected; 2 = same as 1; 3 = part of 1, with healthy fruits; 4 = part of 2, with healthy fruits; 5 = part of 2, with diseased fruits; 6 = part of 1, with diseased fruits; 7 = plant crop of 3; 8 = ratoon of 3; 9 = ratoon of 6; 10 = plant crop of 6; 11 = part of 7, with healthy fruits; 12 = part of 7, with diseased fruits; 13 = part of 8, with healthy fruits; 14 = part of 8, with diseased fruits; 15 = part of 8, with some healthy and some diseased fruits; 16 = part of 9, with some healthy and some diseased fruits; 17 = part of 9, with diseased fruits; 18 = part of 9, with healthy fruits; 19 = part of 10, with diseased fruits; 20 = part of 10, with healthy fruits.*

FIG. 2. Showing possible beneficial effects of plant selection.

Text fig. 2 shows, first, that of the 2,100 fruits tagged only 2,035 were accounted for at harvest owing to mortality due to mealy-bug wilt. Of this number 1,228, or 60.3 per cent, were free from bacterial fruitlet-rot infection, while 807, or 39.7 per cent, were infected; second, that the plant crop of the healthy group had about 31 per cent more healthy fruits than the plant crop of the diseased group, and about 20 per cent more than the plant crop of the unselected group, for the same year (1930); third, that the ratoon of the healthy group had about 11 per cent more healthy fruits than the ratoon of the diseased group; fourth, that the ratoons of both groups had higher percentages of healthy fruits than their respective plant crops; and fifth, that some ratoon plants of either group produced one or two healthy fruits simultaneously with one or two diseased fruits.

These results, although too meager to show anything definite and conclusive, indicate that some strains of the Smooth Cayenne variety are quite resistant to bacterial fruitlet-rots while others are extremely susceptible. It seems possible, therefore, that continuous selection for several years may bring about highly resistant strains that will check the ravages caused by the disease. That ratoon crops are less susceptible to infections than plant crops is to be expected, because ratoon fruits have proved to be less succulent but more acid than plant crop fruits. Quicker and better results may, perhaps, be obtained from this type of selection by spraying the fruits during their development with water suspension of the bacterial pathogens instead of leaving them to casual infections, because in this way only the highly resistant or immune plants, if any, will remain uninfected.

EXPERIMENT 9: MASS SELECTION II

Field observations have shown great variability of the agronomic characters of Smooth Cayenne plants; for example, in the shape and size of fruits grown under apparently identical conditions, in the number of suckers and slips and their positions relative to the fruit, in the opening of the "eyes" or position of the flower bracts at maturity, etc. While such variations may largely be nothing more nor less than the variations within a pure line, it is possible also to find somatic mutations among them. It is likewise possible for such mutants to possess high resistance to, or immunity from, infection, in addition to other important economic characteristics. In order, therefore, to find out the significance of such variations, and to determine whether

or not any correlation exists between certain specific characters of an individual plant and its resistance to, or immunity from, infections, an experiment was conducted, beginning the latter part of 1928, in Santa Fe, Bukidnon Province. This experiment differs from the preceding one in that initial selection was based on the agronomic features of the plants. It should, however, eventually check up the results of the preceding experiment.

Materials and methods.—Smooth Cayenne plants with fruits just maturing and showing agronomic characteristics that made them quite distinct from one another were used. The five most prominent and apparently distinct types described below were selected and numbered 1, 2, 3, 4, and 5, respectively. Numbering was done as in the first selection test, so as to insure the identity of each fruit with its respective crown, slips, suckers, etc., which were to be used for further trials.

Type 1.—Most conspicuous because of its exceptionally large size and rareness; leaves purplish green, proportionally larger and more widely spread than those of other types; produces one or two suckers, rarely three, with usually the same number of shoots as fruit becomes half-developed, but no slips; fruits extraordinarily large, tapering, with small, rather stubby, purplish crown, erect or inclined to one side.

Type 2.—Neither as robust nor as conspicuous as type 1; leaves green with light purplish tint; produces one or two suckers, the same number of shoots, and two or more hapas, but no slips; fruits comparatively smaller than in type 1, cylindrical, usually with smaller eyes, and decidedly inclined to one side at maturity, but with a green crown larger than in type 1.

Type 3.—The same as type 2 except that the fruit is erect even at maturity, owing to ample support provided by a more or less uniform circular distribution of shoots and hapas.

Type 4.—Medium-sized plants with medium-sized green leaves and medium-sized cylindrical, rather large-eyed fruits; produces one or two suckers and five or more slips, but no shoots and no hapas; crown fairly large and well developed.

Type 5.—Essentially the same as type 4 except that the eyes are not as large and more or less tightly closed even during the flowering period.

Results.—As soon as signs of ripening were noticed, the fruits were picked, grouped into their respective types, and taken to the laboratory for the necessary observations, as shown in Table 10.

TABLE 10.—*Reactions of different strains of Smooth Cayenne fruits to bacterial fruitlet-rot infections.*

Type.	Fruits observed.	Average weight.	Pathologic observations.					Color of pulp.	
			Healthy.	Slightly infected.	Severely infected.	Total loss.	Total infection.	Yellow.	White.
		Kg.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	856	3.5	82.0	10.3	7.7	Nil.	18.0	90.1	9.9
2	199	2.8	79.4	13.0	7.1	0.5	20.6	79.5	20.5
3	456	2.8	89.9	10.1	Nil.	Nil.	10.1	67.5	32.5
4	223	2.0	74.8	21.5	2.4	1.3	24.2	63.2	36.8
5	630	2.0	88.4	9.2	2.4	Nil.	11.6	69.7	30.3

Table 10 shows that the total bacterial fruitlet-rot infections found on the different types examined are 18 per cent for type 1, of which 10.3 per cent were slightly infected and 7.7 per cent were severely infected; 20.6 per cent for type 2, of which 13 per cent were slightly infected, 7.1 per cent were severely infected, and 0.5 per cent was a total loss; 10.1 per cent for type 3, all slightly infected; 25.2 per cent for type 4, of which 21.5 per cent were slightly infected, 2.4 per cent were severely infected, and 1.3 per cent were a total loss; and 11.6 per cent for type 5, of which 9.2 per cent were slightly infected and 2.4 per cent were severely infected. It is quite evident from these results that type 3 possesses the highest degree of resistance to the infection, followed closely by type 5. Type 1 seems to represent the mean, and types 2 and 4, the highly susceptible strains. In weight of fruit and richness in color of pulp, the latter one of the factors in grading fruits for canning, type 1 seems to possess ample margin to lead.

Just what particular characters of types 3 and 5 give them a high degree of resistance to infection is not definitely understood. It seems possible, however, that in the case of type 3 the hapas and shoots surrounding the fruit serve as a blanket, partially protecting the fruit from intimate contact with the bacterial pathogens; or, perhaps, the shade furnished by the surrounding hapas and shoots causes enough cooling greatly to lessen the activities of the invading bacterial pathogens. In the case of type 5 perhaps the tightness of the bracts covering the eyes prevents the bacterial parasites, to a large extend, from entering the eye bowl, whence they enter the placental lobes of the fruitlets.

It is not known whether or not any one or all of these five types will breed true, inasmuch as the results of the plantings made from their planting materials are not available and the work has not been carried on over a sufficient length of time to justify any conclusion. These data are here presented for the purpose of suggesting the possibility of finding among the different Cayenne strains a mutant possessing important economic characters as well as a high degree of resistance to fruitlet-rot infections. Should mass selection fail to accomplish the desired end, another method of attack that might serve the same purpose would be hybridization and pedigree selection.

SUMMARY

1. The bacterial fruitlet-rots of the pineapple in the Philippines are so serious and destructive as to endanger the future of the industry unless effective means of control are adopted.

2. There are at least four factors favoring the maladies; namely, incomplete closing of the eyes, fewness of shoots, high temperature, and low acidity of the fruit.

3. Elimination of these factors, particularly low acidity of the fruit, will greatly minimize the ravages caused by fruitlet-rots. Incomplete closing of the eyes and fewness of shoots may, perhaps, be remedied by breeding and selection. The bad effects of high temperature may be partly overcome by shading or by growing the pineapples on high land; for example, at about 2,000 feet above sea level. The low acidity of the fruit may be corrected either by breeding and selection, by the proper application of suitable fertilizers, or proper soil treatment that will endow the soil with a percentage of acidity that is high enough to render the fruits resistant to fruitlet rot without being incompatible with the requirements for good growth.

4. Fortnightly spraying of the young fruits in flower for from three to four months with either Bordeaux mixture or lime-sulphur has given very satisfactory results. Bordeaux mixture of the formula 3–4–50 was used during the first month, followed by a more concentrated solution of 4–5–50 for the rest of the period. In the case of lime-sulphur (33° Baumé) the application was at 1: 80 dilution during the first month and at 1: 70 afterwards.

5. Under Bukidnon Province conditions two applications with potassium sulphate at the rate of 500 kilos per hectare, the first

during the tenth month and the second during the thirteenth month, have reduced the infection by, approximately, 16 to 17 per cent, aside from the increase obtained in yield of 0.2 kilo per fruit, and the increase in acidity from pH 4 to 3.8.

6. There are indications that the increase in acidity of the cell sap as well as the increase in the firmness of the tissues caused by potash treatment are responsible for the resistance shown against infection.

RECOMMENDATIONS

1. *Spraying.*[3]—Where either or both of the diseases are serious enough to warrant the adoption of control measures, fortnightly spraying of the young fruits in flower for from three to four months with either Bordeaux mixture or lime-sulphur, preferably the former, should be practiced. Bordeaux mixture of the formula 3–4–50 should be used during the first month, followed by a more concentrated solution of 4–5–50 formula for

[3] The spray solutions may be prepared as follows:

Bordeaux mixture (3–4–50).—The solution of this formula may be prepared by dissolving 1.36 kilos (3 pounds) of commercial copper sulphate in 10 liters of water (preferably hot to facilitate solution) in a wooden barrel, to which enough water is added later to make 94.5 liters (25 gallons) of the copper sulphate solution. As much as 1.82 kilos (4 pounds) of high-grade quicklime are slaked in about 10 liters of water, and when cold, it is strained into another wooden barrel and enough water is added to make 94.5 liters (25 gallons) of lime solution. The two dilute solutions are then poured together into a third wooden barrel and the mixture is stirred vigorously.

The preparation of the 4–5–50 formula is exactly the same as the 3–4–50, except that more copper sulphate and stone lime have to be used.

Lime-sulphur.—The standard lime-sulphur (33° Baumé) may be prepared according to the best-known formula, 50–100–50, as follows: To suit the actual needs the amount of the ingredient may be altered proportionally; in this case it was reduced to one-tenth. Some water is placed in an iron cooker set on a fire and 2.27 kilos (5 pounds) of high-grade quicklime are dumped into it to slake. When the slaking is well underway, 4.54 kilos (10 pounds) of sulphur powder are added, followed with some more water to maintain a thin paste. As soon as the slaking is completed, enough water is added to make 18.9 liters. Actually, more water should be added to make up for the loss due to evaporation. The mixture is stirred constantly until it boils and assumes a rich amber color and has a hydrometer reading of 33° Baumé. The solution is drawn off into a settling receptacle and after a day clear liquid is decanted into a barrel for storage. The solution is ready for use at any required dilution.

the rest of the period. If lime-sulphur (33° Baumé) is used instead, the dilution should be 1: 80 during the first month and 1:70 afterwards. In any event, the application should be thorough, completely covering the entire fruit and flowers and the immediately surrounding small leaves with a fine mist of the spray. The solutions, especially Bordeaux mixture, must be fresh and should be applied as soon as prepared. Rightly mixed and freshly prepared, Bordeaux mixture is remarkably adhesive and does not yield easily to the washing action of rains.

2. *Fertilizer application and soil treatment.*—The effect of fertilizer application, most particularly of potassium sulphate, should be thoroughly studied. In Santa Fe, Bukidnon Province, two applications with potassium sulphate at the rate of 500 kilos per hectare in two equal replenishments—once during the tenth month and again during the thirteenth month—have given good results. This should be tried in other districts where similar climatic and soil conditions prevail. Sulphur-powder treatment, or any other soil treatment that would produce fruits of high acidity like those of Hawaii should be tried also.

3. *Breeding and selection.*—Breeding and selection for high acidity in terms of pH value aside from other desirable economic characters should also be pursued. The hybrid obtained in Hawaii by crossing Smooth Cayenne with a Brazilian wild variety, which was reported as possessed of high economic value and high acid content, should be tried in the Philippine Islands.

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ILLUSTRATIONS

PLATE 1

TEXT FIGURES

1


DB
NO. 20
SPRAYER
FOR POTATOES, TREES, VINES, SHRUBS.
DISINFECTANTS & WHITEWASH

2

PLATE 1.

NOTES ON PHILIPPINE MOSQUITOES, II

URANOTAENIA GROUP [1]

By F. E. BAISAS

Of the Philippine Health Service, Manila

FOUR PLATES AND ONE TEXT FIGURE

Twelve species are discussed in this paper, seven of which are new. Four of the twelve species have previously been reported by various workers, all the others being now for the first time known to occur in the Philippines. So far I have not encountered three of the seven species heretofore credited to the Islands; namely, *Uranotaenia inontata* Dyar and Shannon (1925), *Uranotaenia nivipes* Theobald (1905), and *Uranotaenia pygmaea* Theobald (1901). Undoubtedly there are other species awaiting discovery.

These mosquitoes are the following:

Uranotaenia annandalei Barraud (1926).

Uranotaenia argyrotarsis Leicester (1908).

Reported as *Pseudouranotaenia parangensis* by Ludlow in Theobald, Mon. Cul. 5 (1910).[2]

Uranotaenia atra Theobald (1905).

Reported as *Uranotaenia caeruleocephala* var. *lateralis* by Ludlow (1905); as *atra* by Dyar and Shannon (1925).

[1] This paper was submitted for publication January, 1935. The work was done in the central laboratory of the malaria section, Philippine Health Service, Manila, of which Dr. Antonio Ejercito is chief. I am greatly indebted to Dr. Ejercito for his unbounded moral support and encouragement; to Dr. Paul F. Russell, of the Rockefeller Foundation, for his help, and for allowing me to have all the culicine mosquitoes collected for him; to Director Angel Argüelles, of the Bureau of Science, and Dr. Marcos Tubangui, of the same bureau, for extending to me the free services of the photographic division of the Bureau of Science; to Dr. José Mendiola for inking all the drawings; and to all other personnel of Malaria Investigations and malaria section who have directly or indirectly helped me in this work. I am also very thankful to Mr. Domingo Santiago, of the School of Hygiene and Public Health, University of the Philippines, for allowing me to go over his collection and lending me some specimens for description, and for comparison with my own.

[2] The synonyms given here are in accordance with F. W. Edwards (1932).

Uranotaenia ludlowae Dyar and Shannon (1925).
Uranotaenia testacea Theobald (1905).
Reported as *U. falcipes* by Banks (1906).
Uranotaenia arguellesi sp. nov.
Uranotaenia tubanguii sp. nov.
Uranotaenia lagunensis sp. nov.
Uranotaenia mendiolai sp. nov.
Uranotaenia heiseri sp. nov.
Uranotaenia delae sp. nov.
Uranotaenia reyi sp. nov.

URANOTAENIA ANNANDALEI Barraud.

Uranotaenia annandalei BARRAUD, Ind. Journ. Med. Res. 14 (1926) 343.

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Baguio (5,000 feet elevation), Mountain Province (*Baisas*); College of Agriculture, Los Baños, Laguna (*Baisas.*)

Adult (male and female).—Head: A border of bluish white scales to eyes, the remainder of head covered with dark brown (dark bluish under certain light) scales, mixed with some upright forked ones on vertex and nape. Tori, clypeus, palpi, and proboscis dark brown. Thorax: Mesonotum dark brown with dark brown scales and dark bristles. A line of bluish white scales from *apn* to pleura, where it joins a bare white patch on mesepimeron. No such scales in front of wing roots but over wing base is a patch of broad grayish brown scales. Some white scales on coxæ. Wings entirely dark-scaled. Abdomen dark above, a little paler beneath. Legs mainly dark, undersides of femora pale.

Male terminalia as illustrated.

Larva.—Head about as long as broad, light brown. Clypeal spines emarginate at tips. *A* finely feathered, slightly flattened, 3-branched [simple in the Indian form according to Barraud (1934) 58 and 76]. *B* and *C* much flattened, dark, spinous laterally, simple; *d* much shorter than *B*, slender, simple; *e* slender, long, simple or forked near base. *Oo* (outer occipital) similar to *e*, 3-branched. Abdomen: *lh* I to III developed, finely feathered. Segment VIII with five to seven comb teeth, which are short, pointed, fringed. Siphon with eight to eleven pecten teeth, which are expanded at tips; tuft finely feathered, 9- to 12-branched, its base situated at about middle of siphon opposite most distal pecten tooth. Anal segment only slightly shorter than siphon, spinous at posterior margin; *isc* and *osc* 2-branched; *lh* short, 2-branched.

URANOTAENIA ARGYROTARSIS Leicester.

Uranotaenia argyrotarsis LEICESTER, Cul. of Malaya (1908) 214. A better description by F. W. Edwards, Bull. Ent. Res. **20** (1929) 312.

Habits.—Larva breeds in forest stream; habits of adults unknown.

Distribution.—Iwahig, Palawan (*Baisas*).

Adult (*male*).—Head: Broad line of bluish white scales to eyes narrowing to a sharp point in front; dark bluish, flat scales cover rest of head, mixed with upright forked ones on vertex and nape. Tori, clypeus, palpi, and proboscis dark brown. Thorax: Pleural line of bluish white scales from *apn* to anterior border of mesepimeron; another line of similar scales from front of wing root to posterior margin of *ppn.* Some white scales on coxæ. Wings mainly dark-scaled; remigium and basal half of stem of vein 5 white-scaled; vein 6 in one specimen has only one dark scale at about middle, two similar scales in the other specimen at about the same situation, the remaining portions bare. Abdomen mainly dark, the pale median apical patches on tergites III and IV ill-marked. Legs mostly dark brown, undersides of femora pale; last three hind tarsal segments and tip of second white. Hind tibia (male) somewhat bent outwardly, and ornamented just before the bend with one straight and two curled bristles. Middle tibia much longer than either fore or hind tibia.

Larva.—Head a little longer than broad, dark brown. Clypeal spines short, stout, pointed. *A* finely feathered, 4- or 5-branched; *B* and *C* much flattened, dark, spinous, simple; *d* slender, 3-branched; *e* long, slender, simple; *oo* similar to *e,* 2-branched. Abdomen: *lh* I and II well developed, finely feathered. Segment VIII: Comb teeth 8 to 10 in number, pointed, fringed. Siphon: Pecten teeth 12 to 14 in number, of the usual type. Tuft finely feathered laterally, 10- or 11-branched, its base situated opposite most distal pecten tooth. Anal segment: *isc* 3-branched; *osc* 2- or 3-branched; *lh* 5-branched.

URANOTAENIA ATRA Theobald.

Uranotaenia atra THEOBALD, Ann. Mus. Nat. Hung. **3** (1905) 114.

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Cotabato, Mindanao (*Ludlow*); Iwahig, Palawan (*Baisas*); Calauan, Laguna (*Santiago*); Tungcong Manga, San Jose, Bulacan (*Baisas*).

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Adult (*male and female*).—Head: A border of bluish white scales to eyes; rest of head clothed with dark bluish or brownish flat scales, mixed with some upright forked ones on vertex and nape. Tori, clypeus, and palpi brownish; proboscis darker. Thorax: Mesonotum dark brown. Some bluish white scales on *apn*, and a large patch of similar scales on sternopleura; between these may be scattered a few similar scales, but they do not join together to form a continuous line. Some white scales on coxæ. A line of bluish white scales in front of wing root extending to posterior margin of *ppn*. Wings entirely dark-scaled. Abdominal tergites dark with apical white lateral patches; sternites mostly pale. Legs mainly dark-scaled, undersides of femora pale. First fore tarsal segment about two-thirds the length of tibia; of hind leg a little shorter than tibia. Legs of male highly modified. A line of blunt flattened spines at one side of apex of fore tibia is a characteristic not mentioned by other workers. In this respect *U. atra* (male) is similar to female *U. delae* and *U. reyi*, which are described in this paper.

Larva.—(Described from one skin from which a male emerged, kindly lent me by Mr. D. Santiago.) Head: A little longer than broad, brown. Clypeal spines short, stout, pointed. *A* finely feathered, 3-branched; *B* and *C* flattened, spinous at sides, simple; *d* not visible; *e* long, slender, forked apically; *oo* about as long and slender as *e*, 3-branched. Abdominal segment VIII with seven or eight fringed, pointed comb teeth. Siphon with eleven or twelve fringed, apically enlarged pecten teeth. Tuft: Base situated at about middle of siphon opposite the second most distal pecten tooth. Anal segment: *isc* and *osc* 2-branched; *lh* short, 10–branched.

URANOTAENIA LUDLOWAE Dyar and Shannon.

Uranotaenia ludlowae DYAR and SHANNON, Insec. Inscit. Mens. 13 (1925) 68.

Habits.—Larva breeds in large, clear, vegetated pools or marshes; habits of adults unknown.

Distribution.—Parang, Cotabato, Mindanao (*Ludlow*); Simoay, Cotabato, Mindanao (*Baisas*); Calauan, Laguna (*Santiago*).

Adult (*female*).—Head: A broad line of bluish white scales bordering eyes; remaining parts with dark brown scales mixed with some upright forked ones on vertex and nape. Tori and clypeus pale brown; palpi and proboscis much darker. Thorax: Integument of mesonotum brown, scales and bristles darker.

Postnotum dark brown; pleura with some pale patches. A line of bluish white scales in front of wing root extending to posterior margin of *ppn.* Pleural line of similar scales from *apn* broadening on sternopleura where it is formed by five or six rows of scales. These scales are well-spread and hardly overlap one another, whereas in *argyrotarsis* (*parangensis*) there are only three rows of scales, which overlap each other considerably. Wings: In both specimens at hand there are one or two white scales at base of remigium, and the extent of white scaling on vein 6, that is, judging from the description given for *argyrotarsis* (*parangensis*) by Dyar and Shannon (1925), is about as much as in *argyrotarsis.* In one specimen two white scales are mixed with the dark ones on the apical dark half of the stem of vein 5. Vein 6 in one specimen has only a single white scale at about the apex of the basal third, the rest towards the apex dark-scaled, towards the base bare. In the other specimen there is one white scale at about the same situation on vein 6, but basal to it is a single dark scale, the remaining portion basally being bare, and apically dark-scaled. Abdominal tergites dark brown; sternites mainly pale. Legs mostly dark-scaled, undersides of femora pale. Last two hind tarsal segment white, the third pale beneath throughout its entire length, but dark above from base to a short distance before the apex.

Larva.—Head a little longer than broad, brown. Clypeal spines short, stout, pointed. *A* somewhat flattened, spinous, 3-branched; *B* and *C* much more flattened than *A*, dark, spinous laterally, simple; *d* flattened, spinous, simple; *e* long, slender, 2- or 3-branched apically; *oo* finely feathered, 5- or 6-branched. Antenna as illustrated. Abdomen: *lh* I and II developed. Segment VIII with eight or nine comb teeth, which are pointed, fringed. Siphon with eleven or twelve pecten teeth of the usual type. Tuft scantily feathered, 11 to 16-branched, its base opposite the second most distal pecten tooth. Anal segment: *osc* missing; *isc* 4- or 5-branched; *lh* 9- to 14-branched.

URANOTAENIA TESTACEA Theobald.

Uranotaenia testacea THEOBALD, Ann. Mus. Nat. Hung. 3 (1905) 113.

Habits.—Larva breeds in forest stream; habits of adults unknown.

Distribution.—Rizal waterworks, Camp 320, Manila (*Banks*); Tungcong Manga, San Jose, Bulacan (*Baisas*).

Adult (*male and female*).—Head: Extensive bluish white scales to eye margins, broadening at sides; remaining areas clothed with dark flat scales, mixed with some upright forked ones on vertex and nape. Thorax: Pleural line of bluish white scales covers *apn* and extends to anterior margin of mesepimeron. No line of such scales in front of wing roots. Wings entirely dark-scaled. Abdomen dark above, much paler beneath. Legs mostly dark brown, undersides of femora pale. Unlike the Indian form, the local species has the whole of the last three hind tarsal segments and apex of the second completely white.

URANOTAENIA ARGUELLESI sp. nov.

Type.—Male (lot R40–xx) and female (lot R40–yy).

Cotypes.—Two males and 2 females. Types and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Calauan, Laguna, Luzon.

Collector.—F. E. Baisas.

Date of collection.—February 25, 1930.

Habits.—Larva breeds in impounded, clear, vegetated water; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Head: A well-defined line of bluish white scales to eye margins, forming a sharp point in front; remaining portions of head covered with dark, flat scales, mixed with some upright, forked scales on vertex and nape. Tori and clypeus brown; proboscis slightly shorter than front femur, dark brown. Thorax: Integument of mesonotum dark brown, scales dark brown, bristles darker. A line of bluish white scales in front of wing root to posterior margin of *ppn*. A similar line runs across pleura, including *apn*, to anterior margin of mesepimeron. Postnotum and pleura dark brown. Wings mostly dark-scaled; extreme base of costa white in some individuals; remigium, basal half of stem of vein 5, and basal third to half of vein 6 white-scaled. *Af* not much smaller than *pf*. Abdominal tergites I to III completely white dorsally, IV white apically, V with complete apical band. VI and VII entirely dark. Sternites mostly pale. Legs mainly dark-scaled, undersides of femora pale.

Male terminalia as figured.

Larva.—Head a little longer than broad, very dark. Clypeal spines short, stout, pointed. *A* slightly flattened, finely feathered, 4- or 5-branched; *B* and *C* flattened, dark spinous laterally, simple; *d* slender, 2-branched; *e* slender, long, forked

apically or about middle; *oo* about as long and slender as *e*, 3-branched. Abdomen: Segment VIII with eight or nine comb teeth, which are pointed, fringed. Siphon with about twelve pecten teeth, which are much enlarged apically, fringed. Tuft finely feathered, 12-branched, its base opposite most distal pecten tooth. Anal segment: *isc* 3-branched; *osc* 2-branched; *lh* 5- or 6-branched.

This species is named for Dr. Angel S. Argüelles, director of the Bureau of Science.

URANOTAENIA TUBANGUII sp. nov.

Type.—Male [lot R110 (a)-1], and female [lot R110 (a)-2].

Cotypes.—Six males and 4 females. Types and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Kolambugan, Lanao, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—July 30, 1934.

Habits.—Larva breeds in large numbers in tree holes; many adults near the point of breeding, apparently not human biters.

Distribution.—Known also from the mountains of Calauan, Laguna (*Santiago*).

Adult (*male and female*).—Head with a patch of dull bluish white scales on lateral sides to eye margins, continued to front by a narrow line of dull pale brown scales; remaining parts clothed with dark brown (dark bluish under certain light) scales, mixed with upright, forked, dark scales (whose apices are much more expanded than in other species) on vertex and nape to near eye margins. Tori, clypeus, and palpi dark brown. Proboscis about five-eighths the length of front femur, dark brown. Thorax: Mesonotum dark brown, scales paler, bristles rather few, dark. In front of wing roots along margin of mesonotum to front is a line of pale scales visible as a broad pale line under a certain angle. It is not, however, like the usual bluish white scales found in other species, although a few scales immediately near the wing roots are broader. Postnotum paler than integument of mesonotum. Pleura including *apn* devoid of scales. The upper portion of pleura from a line following lower margin of mesepimeron distinctly dark brown; the lower part including coxæ and trochanters paler. Indefinite black areas scattered on upper portion of pleura. Wings entirely dark-scaled. *Af* distinctly smaller than *pf*. Legs dark brown, undersides of femora pale; no peculiar modifications. Abdominal tergites entirely dark; sternites scarcely less so.

Larva.—Head about as long as broad, light brown. Clypeal spines directed upwards, less stout, and shorter than in other species. *A* long, slender, simple; *B* and *C* longer than *A*, slender, simple; *d* small, 4- or 5-branched; *e* long, slender, 2- or 3-branched apically; *oo* very small, 5- to 7-branched. Thorax much broader and thicker than in other species. One of the anterior, submedian, thoracic hairs unusually long, extending beyond the rim of head by about half its length. Abdomen: *lh* I and II finely feathered, developed, simple. Segment VIII with eight to ten pointed, fringed comb teeth. Siphon much longer than in other species (index 5). Sixteen or seventeen pecten teeth, short, fringed, expanded apically. Tuft 2- to 4-branched, its base situated about midway between most distal pecten tooth and apex of siphon. Anal segment of the usual type; *isc* and *osc* each simple; *lh* short, simple.

Larva is easily determined macroscopically by the presence of a large white patch on thorax.

This species is named for Dr. Marcos A. Tubangui, of the Bureau of Science.

URANOTAENIA LAGUNENSIS sp. nov.

Type.—Male (lot F149) and female (lot F149–5) with larval skin.

Isotypes.—Eight males and 7 females. Types and isotypes in the collection of the Bureau of Health, Manila.

Type locality.—College of Agriculture, Los Baños, Laguna.

Collector.—F. E. Baisas.

Dates of collection.—March 17, 1930, and November 4, 1934.

Habits.—Larva breeds in rock holes in forest creek; habits of adults unknown.

Distribution.—Found also in Limay, Bataan (*United States Army Medical Department Research Board*); and Iwahig, Palawan (*Baisas*).

Adult (*male and female*).—Head covered with brown scales, those along the eyes paler, but not forming a distinct white line. Dark, upright, forked scales having tips about as expanded as those of *tubanguii* scattered on vertex and nape to near eye margins. Clypeus and palpi dark brown. Tori lighter in color. Proboscis about four-fifths the length of front femur, dark brown. Thorax: Integument of mesonotum as well as postnotum and pleura brown; mesonotal scales brown, bristles numerous, dark. No line of bluish white scales in front of wing roots or on pleura. Dark brown flat scales cover *apn;*

a large patch of similar scales on sternopleura; similar scales scattered elsewhere on pleura and coxæ. Wings entirely dark-scaled. *Af* much smaller than *pf*. Abdominal tergites dark with distinct pale basal bands on II to VII; sternites pale. Legs mostly dark-scaled, undersides of femora pale. First hind tarsal segment in both sexes longer than tibia.

Male terminalia as illustrated.

Larva.—Head about as long as broad, brown. Clypeal spines stout, short, pointed, brown. *A* finely feathered, 4- to 6-branched; *B* and *C* long, narrow, only slightly flattened, finely spinous laterally, simple; *d* posterior but internal to *C*, and anterior to *B*, small, 3-branched; *e* slender, simple, or forked at about middle; *oo* finely feathered, 2-branched. Antenna as figured. Abdomen: *lh* I and II developed, finely feathered. Segment VIII with ten or eleven pointed, fringed comb teeth. Siphon with about twenty-four to twenty-eight pecten teeth of the usual type. Tuft finely feathered, 6- to 8-branched, its base variably situated opposite either one of the three most distal pecten teeth. Anal segment of the usual type; *isc* and *osc* 2-branched; *lh* finely feathered, 2-branched.

URANOTAENIA MENDIOLAI sp. nov.

Type.—Male (lot F153–7) and female (lot F153–5) with their larval skins.

Cotypes.—Eight males and 3 females.

Isotypes.—One male and 2 females. Types, cotypes, and isotypes in the collection of the Bureau of Health, Manila.

Type locality.—College of Agriculture, Los Baños, Laguna.

Collector.—F. E. Baisas.

Dates of collection.—March, 1930; November, 1934; and January, 1935.

Habits.—Larva breeds in rock holes in forest creek, also along stagnated clear edges of creek; habits of adults unknown.

Distribution.—Known also from Limay, Bataan (*United States Army Medical Department Research Board*).

Adult (male and female).—Head mainly clothed with dark, broad, flat scales; a border of bluish white scales to eyes continued to front; a few dark, upright, forked scales on nape. Tori, clypeus, and palpi dark brown. Proboscis about three-fourths the length of front femur, dark above, somewhat paler beneath. Thorax: Mesonotal scales and integument dark brown; bristles darker. A line of bluish white scales in front of wing root, extending along border to front of mesonotum. A similar

line on pleura from *apn* to anterior border of mesepimeron where it joins a pale bare patch. Similar scales scattered elsewhere on pleura and coxæ. Postnotum dark brown. Wings mostly dark-scaled; remigium and a varying portion of base of vein 1 white-scaled; in some individuals there are a few dark scales on anterior apical border of remigium. *Af* smaller than *pf*. Abdominal tergites I and II completely white dorsally; III and IV with median apical white patches; V and VI with complete apical white bands; VII entirely dark. Sternites dark brown. Legs mostly dark brown, undersides of femora pale. A line of white scales in front of midfemur, extending from base to about two-thirds or more the length of the segment. Femora and tibia with pale apices; fore and midtarsi except the last pale at the joints; hind tarsal segments 1 to 3 with pale apical and basal rings; last two segments completely white in most individuals, imperfectly so in some.

Male terminalia as illustrated.

Larva.—Head a little longer than broad, very dark. Clypeal spines of the usual type. *A* finely feathered, slightly flattened, 3- to 5-branched; *B* and *C* much flattened, spinous laterally, dark; *d* very slender, 2- or 3-branched; *e* slender, forked at a little beyond the middle towards the apex; *oo* 3-branched. Abdomen: *lh* I and II finely feathered, developed. Segment VIII with eight to ten comb teeth, which are pointed, fringed. Siphon with about fourteen pecten teeth, of the usual type. Tuft: Base situated at about middle of siphon opposite the most distal pecten tooth, finely feathered, about 12-branched. Anal segment: *isc* 3-branched; *osc* 2-branched; *lh* 4- or 5-branched.

This species is named for Dr. J. Mendiola, of the Bureau of Health.

URANOTAENIA HEISERI sp. nov.

Type.—Female (lot R85–1) with its larval skin, in the collection of the Bureau of Health, Manila.

Type locality.—Parang, Cotabato, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—July 5, 1934.

Habits.—Larva breeds in fresh-water swamps; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (female; male unknown).—Head mainly covered with broad, flat, dark scales, mixed with a few upright forked scales on vertex and nape. A border of a well-defined line of bluish

white scales to eyes, meeting in a sharp point in front. Tori, clypeus, and palpi dark. Proboscis about three-fourths the length of front femur, dark brown. Thorax: Integument and scales of mesonotum dark brown; bristles darker. A line of bluish white scales from front of wing root to posterior margin of *ppn*. Postnotum brown; pleura darker. Another line of bluish white scales from *apn* to pleura terminating at the anterior border of mesepimeron where it meets a pale bare patch. Some white scales on coxæ. Wings mostly dark-scaled. Remigium and a short portion of base of vein 1 white-scaled. Abdomen entirely dark dorsally; a white, apical, lateral patch on V. Venter of abdomen paler. Legs dark brown, undersides of femora pale. No peculiar modifications.

Larva.—Head longer than broad, very dark. Clypeal spines of the usual type. *A* finely feathered, slightly flattened, 3-branched. *B* and *C* much flattened, spinous laterally, dark, simple. *d* not visible; *e* and *oo* missing. Antenna as figured. Abdomen: *lh* I and II finely feathered, developed. Segment VIII with six or seven pointed, fringed comb teeth. Siphon with eleven pecten teeth, which are shorter and much more expanded at apices than in other species; tuft unfeathered, 12-branched, its base situated opposite the most distal pecten tooth. Anal segment: *isc* 3-branched; *osc* missing; *lh* 5- to 7-branched.

This species is named for Dr. Victor G. Heiser, of the Rockefeller Foundation.

URANOTAENIA DELAE sp. nov.

Type.—Female (lot R83–30) with its larval skin, in the collection of the Bureau of Health, Manila.

Type locality.—Salimbao, Cotabato, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—July 4, 1934.

Habits.—Larva breeds in fresh-water marsh; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (female; male unknown).—Head mainly covered with dark, broad, flat scales dorsally, mixed with a few upright, forked scales on vertex and nape. A broad line of bluish white scales to border of eyes meeting in a point at front. Antennæ, clypeus, and palpi dark brown. Proboscis about as long as front femur, dark brown above, paler beneath at middle. Thorax: Integument, and scales of mesonotum dark brown. Postnotum dark brown. A line of bluish white scales in front

of wing root extending to posterior margin of *ppn*. Another line of similar scales from *apn* to anterior margin of mesepimeron. Wings mainly dark-scaled; posterior margin of remigium and basal fourth of stem of vein 5 white-scaled. *Af* much smaller than *pf*. Abdomen dark brown dorsally, a little paler beneath. Legs mostly dark-scaled, undersides of femora pale; last three hind tarsal segments and apex of second white. Fore tibia with peculiar ornamentation (as illustrated) at apex; second tarsal segment distinctly shorter than either the first or the third, thickened with numerous long hairs on one side and a line of well-separated long hairs on the side opposite. Midtibia very much longer than femur or first tarsal segment; last three tarsal segments very short and somewhat thickened, all the three together only about one-half as long as the second. First hind tarsal segment about as long as tibia.

Larva.—Head about as long as broad, fairly dark. Clypeal spines short, stout, dark. *A* long, somewhat flattened, finely feathered, 2-branched; *B* and *C* much flattened, dark, simple, spinous laterally; *d* about as broad as, but longer than, *A*, simple; *e* small, simple; *oo* 5-branched. Antenna as illustrated. Abdomen: *lh* I and II finely feathered, developed. Segment VIII with eight or nine comb teeth, which are pointed, fringed. Siphon with ten or eleven pecten teeth, which are expanded at tips, fringed. Tuft 8-branched, its base situated opposite the second or the third most distal pecten tooth. Anal segment of the usual type; *isc* 3-branched; *osc* 2-branched; *lh* 4-branched.

URANOTAENIA REYI sp. nov.

Type.—Female (lot R94–22) with its larval skin.

Cotypes.—Two females, one of which has its larval skin. Another female with its larval skin collected from a nearby locality. All these are in the collection of the Philippine Health Service, Manila.

Type locality.—Simoay, Cotabato, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—July 9, 1934.

Habits.—Larva breeds in wide, vegetated, clear pool or marsh; habits of adults unknown.

Distribution.—Known also from Parang, Cotabato, Mindanao.

Adult (female; male unknown).—Head with a wide border of bluish white scales to eyes; dark, broad, flat, and upright, forked scales on vertex and nape. Tori and clypeus brown; palpi darker. Proboscis slightly shorter than front femur, dark

brown above, paler beneath. Thorax: Mesonotum dark brown. A line of bluish white scales in front of wing root, extending to posterior margin of *ppn*. A broader line of similar scales from *apn* to pleura where it expands considerably as it reaches

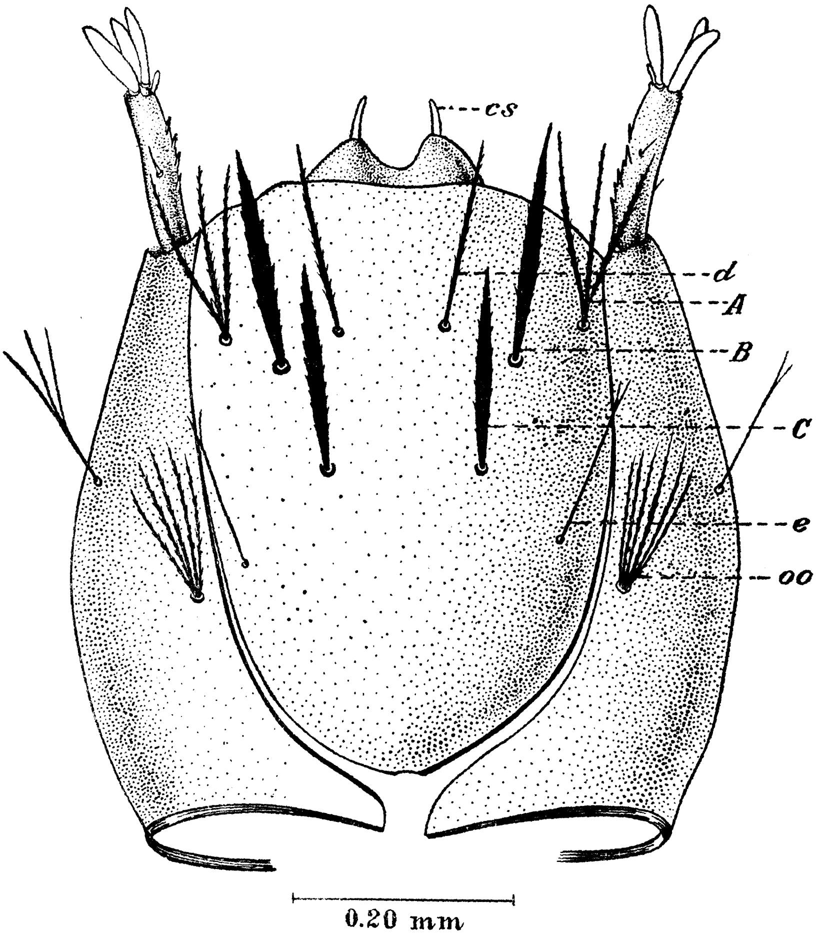

FIG. 1. *Uranotaenia reyi* sp. nov.; head, showing hairs of diagnostic value, in accordance with Edwards (1928) 338. (From a camera-lucida drawing.)

A, Outer postantennal hair of Lang.
B, Mid postantennal hair of Lang.
C, Inner postantennal hair of Lang.
d, Preantennal hair of Lang.
e, Vertical hair of Lang.
oo, Outer occipital hair.
cs, Clypeal spine.

the sternopleura, and joins a white bare patch on mesepimeron. Postnotum dark brown; pleura a little less so. Wings mainly dark-scaled; lower border of remigium and a little less than basal third of stem of vein 5 white-scaled. In one individual

only about basal one-fourth of stem of vein 5 is white and among these white scales is mixed a black one. Vein 6 in all specimens scaleless or with only one or two dark scales at about the middle. *Af* much smaller than *pf*. Abdominal tergites dark brown with pale lateral patches more conspicuous in some individuals or in some segments than in others. Legs mostly clad with dark scales, undersides of femora pale; last three hind tarsal segments and a varying portion of the apex of second white. Fore tibia with a bunch of long bristles apically on one side and a row of blunt-ended, flattened spines similar to those of *delae* or *atra* (as illustrated). First fore tarsal segment, with numerous long hairs basally, distinctly shorter than tibia; second segment still shorter, but not ornamented as that of *delae;* third longer than first, and fourth about three times as long as fifth. Midtibia very much longer than femora, twice as long as first tarsal segment; second, half as long as first; third, over half as long as second; fourth, very short and stout, shorter than fifth, the last three segments together a little longer than second. First hind tarsal segment shorter than tibia.

Larva.—Head a little longer than broad, dark brown; clypeal spines of usual type. *A* somewhat flattened, finely feathered, 3-branched; *B* and *C* flattened, spinous laterally, simple; *d* fairly stout, spinous laterally, simple; *e* long, slender, forked at extreme apex; *oo* finely feathered, 5- to 8-branched. Antenna as figured. Abdomen: *lh* I and II finely feathered, developed. Segment VIII with eight to ten pointed, fringed comb teeth. Siphon with eleven or twelve pecten teeth, of the usual type. Tuft finely feathered, 13- to 15-branched, its base situated opposite the second most distal pecten tooth. Anal segment of the usual type; *isc* 5-branched; *osc* 2-branched; *lh* finely feathered, 9 to 12-branched.

Key to the adults of Philippine species of Uranotaenia.

1.	Wings entirely dark-scaled	2.
	Wings with some white scales	3.
2.	Pleura with conspicuous lines or patches of bluish white scales	4.
	Pleura bare or with patches of brownish scales	5.
3.	Hind tarsi with white markings	6.
	Hind tarsi entirely dark	7.
4.	Hind tarsi with white markings	*testacea.*
	Hind tarsi entirely dark	8.
5.	Abdominal tergites with white basal bands	*lagunensis.*
	Abdominal tergites entirely dark	*tubanguii.*
6.	Female foreleg markedly modified; male unknown	9.
	Female foreleg not modified	10.

7. Abdominal tergites I to IV with white median patches; V with complete apical band .... *arguellesi.*
   Abdominal tergites I to V without white median patches, but terminal ones with pale lateral patches........ *heiseri.*
8. A line of bluish white scales from wing root to posterior margin of *ppn;* male legs highly modified........ *atra.*
   No such line of bluish white scales, but some grayish brown scales over wing root .... *annandalei.*
9. First fore tarsal segment with outstanding hairs towards the base; second without such hairs .... *reyi.*
   First fore tarsal segment with no outstanding hairs, but second with numerous outstanding hairs .... *delae.*
10. Abdominal tergites entirely dark-scaled; hind tibia of male without curled bristles .... *ludlowae.*
    Abdominal tergites I to V with median apical white patches; VI and VII completely banded apically; hind tibia of male without curled bristles .... *mendiolai.*
    Abdominal tergites III and IV only with pale median patches; hind tibia of male with curled bristles .... *argyrotarsis.*

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ILLUSTRATIONS

PLATE 1. MODIFICATION OF LEGS

FIG. 1. *Uranotaenia atra* Theobald; tip of fore tibia, first fore tarsal segment, and base of second tarsus.
2. *Uranotaenia reyi* sp. nov., tip of fore tibia and base of first fore tarsal segment.
3. *Uranotaenia delae* sp. nov., tip of fore tibia and base of first fore tarsal segment.

PLATE 2. COXITE AND STYLE OF MALE TERMINALIA AND LEGS

FIG. 1. *Uranotaenia testacea* Theobald.
2. *Uranotaenia arguellesi* sp. nov.
3. *Uranotaenia tubanguii* sp. nov.
4. *Uranotaenia annandalei* Barraud.
5. *Uranotaenia atra* Theobald.
6. *Uranotaenia argyrotarsis* Leicester.
7. *Uranotaenia mendiolai* sp. nov.
8. *Uranotaenia lagunensis* sp. nov.
9. *Uranotaenia delae* sp. nov., second fore tarsal segment.
10. *Uranotaenia argyrotarsis* Leicester, hind tibia.

PLATE 3. ANTENNÆ OF LARVÆ

FIG. 1. *Uranotaenia arguellesi* sp. nov.
2. *Uranotaenia annandalei* Barraud.
3. *Uranotaenia mendiolai* sp. nov.
4. *Uranotaenia heiseri* sp. nov.
5. *Uranotaenia tubanguii* sp. nov.
6. *Uranotaenia atra* Theobald.
7. *Uranotaenia argyrotarsis* Leicester.
8. *Uranotaenia delae* sp. nov.
9. *Uranotaenia lagunensis* sp. nov.
10. *Uranotaenia ludlowae* Dyar and Shannon.
11. *Uranotaenia reyi* sp. nov.

PLATE 4. PORTIONS OF HEADS OF LARVÆ SHOWING DIAGNOSTIC HAIRS

FIG. 1. *Uranotaenia delae* sp. nov.
2. *Uranotaenia heiseri* sp. nov.
3. *Uranotaenia reyi* sp. nov.
4. *Uranotaenia ludlowae* Dyar and Shannon.
5. *Uranotaenia tubanguii* sp. nov.
6. *Uranotaenia argyrotarsis* Leicester.
7. *Uranotaenia arguellesi* sp. nov.
8. *Uranotaenia mendiolai* sp. nov.
9. *Uranotaenia annandalei* Barraud.
10. *Uranotaenia lagunensis* sp. nov.
11. *Uranotaenia atra* Theobald.

TEXT FIGURE

FIG. 1. *Uranotaenia reyi* sp. nov.; head, showing hairs of diagnostic value, in accordance with Edwards (1928) 338. (From a camera-lucida drawing.)

A, Outer postantennal hair of Lang.
B, Mid postantennal hair of Lang.
C, Inner postantennal hair of Lang.
d, Preantennal hair of Lang.
e, Vertical hair of Lang.
oo, Outer occipital hair.
cs, Clypeal spine.

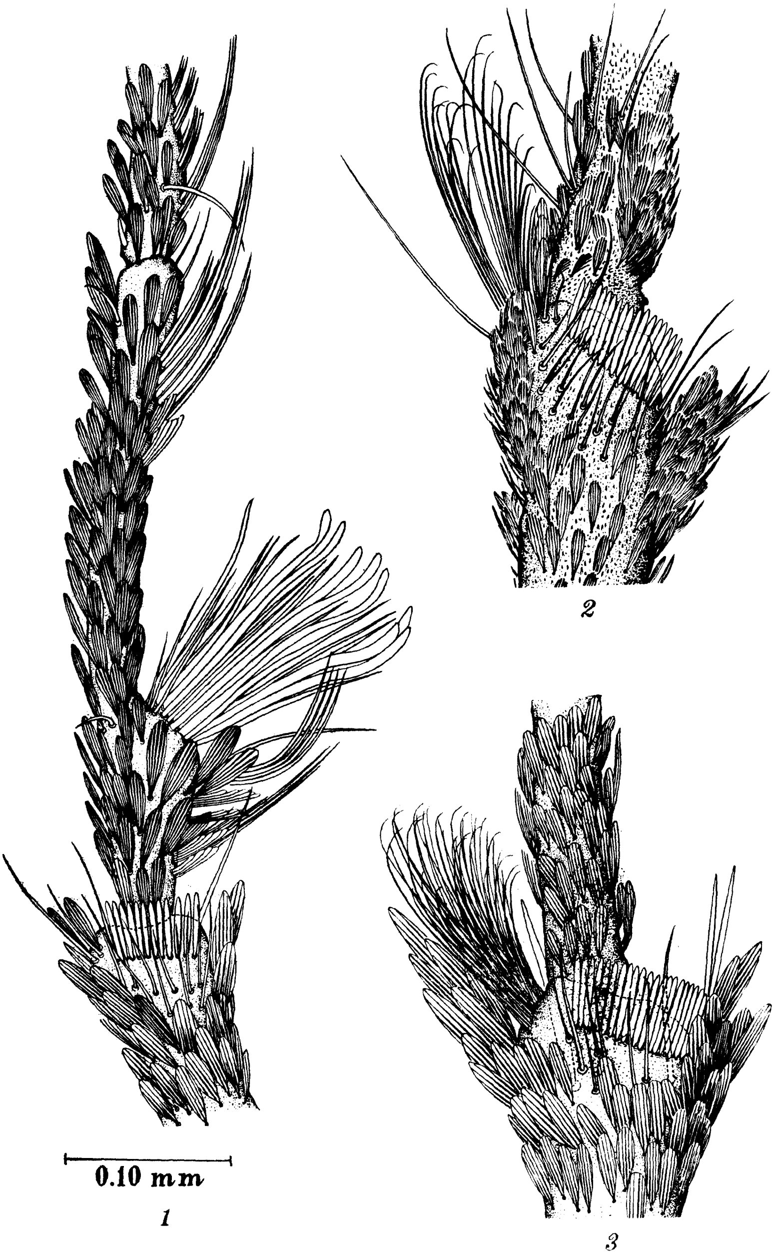


PLATE 1.

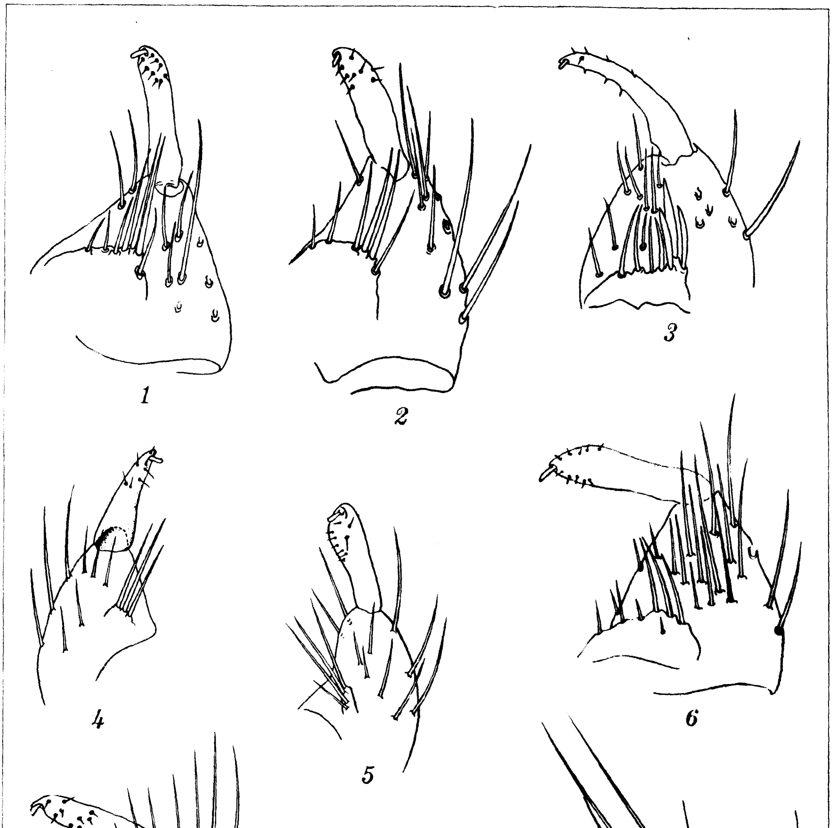


PLATE 2.

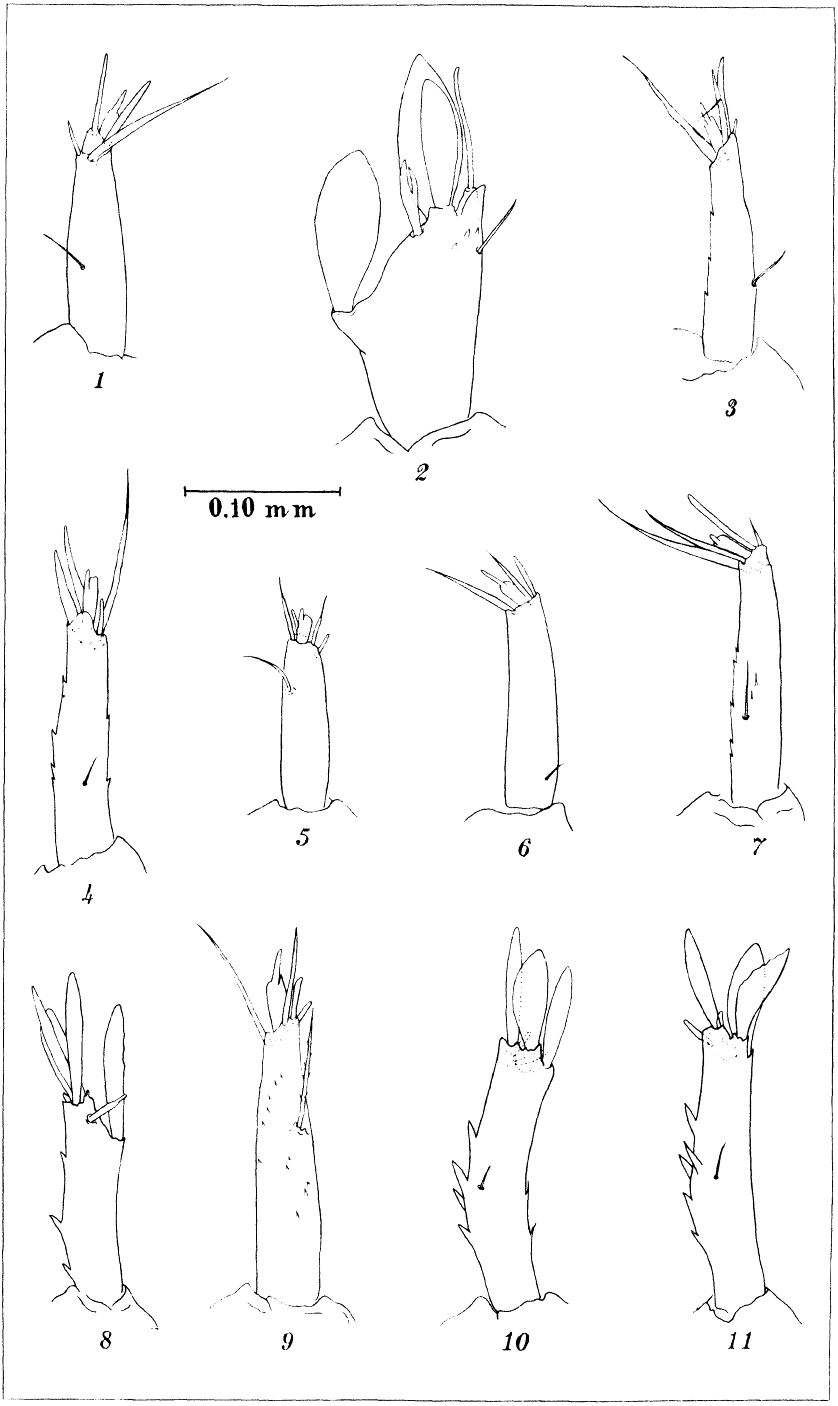


PLATE 3.

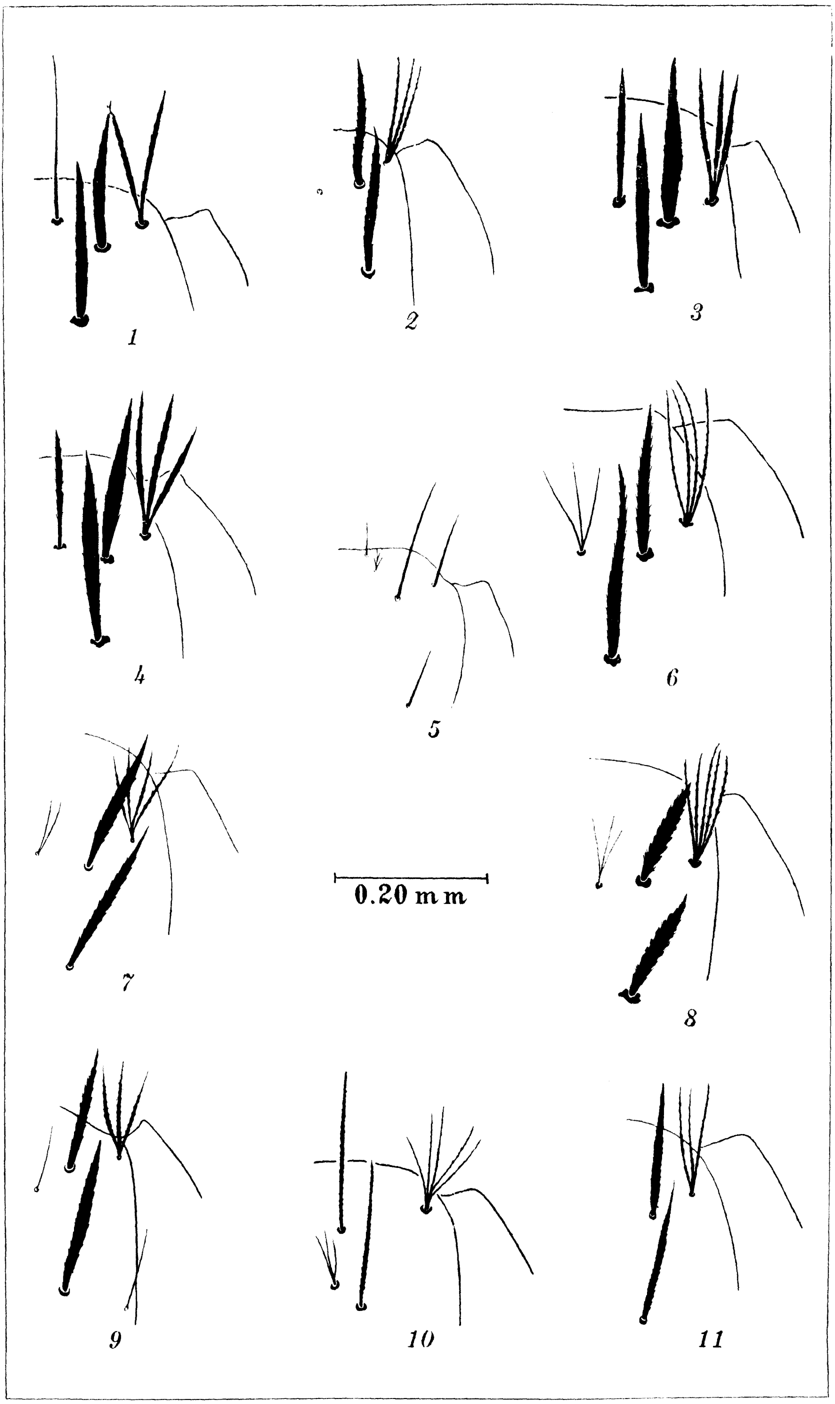


PLATE 4.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXV[1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

FOUR PLATES

In the present report I have considered a series of tipuline crane flies, all from Szechwan, western China, with the exception of two species, of which specimens were sent to me some years ago from Chekiang, by Mr. E. Suenson. The rich material discussed herewith is, in large part, collections made by the Rev. Mr. David C. Graham, and the resulting types are preserved in the United States National Museum. Still other species were taken on Mount Omei by the Rev. Mr. George M. Franck, and this material is preserved in my own collection. A few additional species were secured by Herr Friedrich, the types of which are preserved in the Deutsches Entomologisches Museum, Berlin-Dahlem, from whence they were loaned to me for study through the kind interest of Dr. Walther Horn. I record here my deepest thanks to each of the above-mentioned entomologists for this continued kindly coöperation.

At the same time I have discussed in some detail the species of *Tipula* in eastern Asia and have attempted to assign each of the numerous described forms to its proper subgenus.

TIPULINÆ

Genus TIPULA Linnæus

Tipula LINNÆUS, Systema Naturæ ed. 10 (1758) 585.

Nearly one-half of all the species of *Tipula* that have been described to date occur within the faunal limits considered in the present report. This vast series of more than 400 species has become increasingly difficult to handle, following the accession in recent years of numerous additions to an already cumbersome list. It, therefore, seems appropriate at this time to record the species known from this area and to make an attempt

[1] Contribution from the entomological laboratory, Massachusetts State College.

to place them in subgeneric groups, a first noteworthy effort toward which was made by Edwards in 1931.[2]

The key that is provided is tentative only and of necessity has been based in part on male and female sexual characters. In defining the subgeneric groups and recording the range of characters in each, particular stress has been devoted to the subgenotype of the various groups, virtually all of which have been available for study. The species have been distributed into what seem to be their proper subgenera, but authentic specimens of a considerable number of species have not been available to me and the assignment of such forms is entirely provisional. There remain further various species that are so aberrant in their characters that it seems inadvisable at this time to attempt to place them definitely in subgeneric groups, and these forms are recorded in a separate list.

A vast amount of work remains to be done upon this genus in eastern Asia, and the present attempt must be held as being merely preliminary. Despite the high percentage of species in this faunal area as compared with the remainder of the World, it seems probable that this will not be materially lowered following the continued discovery of new forms. The Himalayan region, Tibet and western China, together with the mountains of Indo-China and the Malayan islands, all appear to support a rich fauna in this group, only poorly known at the present time. It seems improbable to me that the discovery of novelties in this genus in Europe, Africa, North America, and South America will much more than keep pace with their continued development in eastern Asia. It should be further emphasized that New Zealand and the Polynesian islands have no species of *Tipula* and that to this date only two species (*Indotipula*) have been taken in Australia, which are included in this report in order to complete the data.

The species are recorded in this paper under three geographic units, defined as follows:

1. Palæarctic Eastern Asia.—Eastern Siberia; Manchukuo; Korea; Japan; Formosa; eastern China, south to 30° north latitude.

2. Palæarctic Central Asia.—Central and Arctic Siberia; Mongolia; Sinkiang; western China, including Kansu, Szechwan,

[2] Ann. & Mag. Nat. Hist. X 8 (1931) 73–82.

Kweichow, and Yunnan; Tibet; the Himalayan region, including Kashmir, eastern Punjab, Garhwal, Nepal, Sikkim, and Bhutan, as well as the Himalayan northern sections of Assam and Burma.

3. Oriental Eastern Asia.—Eastern China, south of 30° north latitude; India, Assam, and Burma, south of the Himalayas; Siam; French Indo-China; Malay Peninsula; East Indian Archipelago, including New Guinea and satellite islands; northern Australia.

I include Formosa in the Palæarctic Region despite it geographic position south of 30° north latitude. Most of the crane flies so far taken on the island, including all species of *Tipula*, are from high altitudes where conditions are definitely Palæarctic.

The subgenera of Tipula in central and eastern Asia.

1. *Brithura* Edwards.
2. *Nippotipula* Matsumura.
3. *Sinotipula* subg. nov.
4. *Trichotipula* Alexander.
5. *Schummelia* Edwards.
6. *Formotipula* Matsumura.
7. *Tipula* Linnæus.
8. *Yamatotipula* Matsumura.
9. *Acutipula* Alexander.
10. *Indotipula* Edwards.
11. *Papuatipula* Alexander.
12. *Tipulodina* Enderlein.
13. *Arctotipula* Alexander.
14. *Vestiplex* Bezzi.
15. *Oreomyza* Pokorny.
16. *Lunatipula* Edwards.

A key to the subgenera of the genus Tipula in central and eastern Asia, based in part on sexual characters.

1. Outer cells of wing with macrotrichia .... 2.
   Cells of wing without macrotrichia .... 4.
2. Squama with setæ .... 5. *Schummelia*.
   Squama naked .... 3.
3. Rs elongate, exceeding twice the length of m-cu, the latter at near mid-length of cell 1st M_2 .... 15. *Oreomyza*.
   Rs short, subequal to m-cu, the latter just beyond the fork of M, close to the base of cell 1st M_2 .... 4. *Trichotipula*.
4. Vein Sc_1 present .... 1. *Brithura*.
   Vein Sc_1 lacking .... 5.
5. Rs in alignment with R_{4+5}, the basal deflection of the latter lacking; m-cu uniting with M_{3+4} some distance before fork of latter, very rarely (*phædina*) at fork; Rs unusually long, fully twice m-cu; anepisternum with setæ .... 2. *Nippotipula*.
   Basal section of R_{4+5} present; m-cu at fork of M_{3+4} or beyond on base of M_4; Rs of moderate length, ranging to one-half longer than m-cu, in some cases (as *Yamatotipula*, *Sinotipula*, *Vestiplex*, and *Oreomyza*) attaining to fully twice this length, but, if so, with the basal section of R_{4+5} preserved; anepisternum glabrous .... 6.

6. Anterior vertex produced, a slender simple lobe; pleurotergal tubercle large, with velvetlike pubescence on dorsal face; body very stout; often with setæ on dorsal sternopleurite.. 1. *Brithura*.
   Anterior vertex without such a lobe, at most merely protuberant; pleurotergite not elevated into a tubercle; body relatively slender; sternopleurite glabrous (except in some species of *Arctotipula*, *Vestiplex*, and *Lunatipula*) .... 7.
7. Body coloration contrasted black and orange, the thorax either chiefly velvety black or else a shade of orange or reddish; ovipositor with short fleshy valves; male hypopygium with a single complex dististyle. 6. *Formotipula*.
   Body coloration not contrasted black and orange as above; ovipositor with elongate sclerotized cerci (except in *Arctotipula* and some *Lunatipula* species); male hypopygium with two dististyles................ 8.
8. Legs very elongate, with snowy-white rings on femora, tibiæ, or tarsi. 12. *Tipulodina*.
   Legs of moderate length, without white rings.. 9.
9. Fore tibiæ without spurs.. 10. *Indotipula*.
   Fore tibiæ with a single spur.. 10.
10. Wings with m-cu unusually long, so cell M_4 is very deep and much wider at base than at margin; vein Cu_1 not conspicuously constricted at point of insertion of m-cu; male hypopygium with a compressed median blade on tergite or else with caudal margin notched. 5. *Schummelia*.
    Wings with m-cu of moderate length, so cell M_4 is short and but little wider at base than at margin; Cu_1 more constricted or shirred at point of insertion of m-cu; male hypopygium with tergite not extended into a median compressed blade (where with a median lobe, as *Tipula*, *Yamatotipula*, *Acutipula*, and *Indotipula*, this depressed and set with microscopic spicules at and near apex).................... 11.
11. Ovipositor with hypovalvæ greatly reduced, the cerci correspondingly large, heavily sclerotized, placed horizontally and with the outer margins serrate; male hypopygium with the caudal portion of tergite often with a shallow, blackened, saucerlike portion, or else completely divided on midline by pale membrane; many species with an acute spine at caudal portion of basistyle; claws (male) simple. 14. *Vestiplex*.
    Ovipositor with well-developed hypovalvæ; cerci either reduced and somewhat fleshy (*Arctotipula* and some *Lunatipula*) or, usually, elongate and slender, the margins quite smooth; male hypopygium without a tergal saucer and only in rare instances divided by pale membrane; basistyle not or only rarely (*Oreomyza*) produced at apex into an acute spine; claws (male) usually with a basal tooth.. 12.
12. Male hypopygium with sclerites fused into a continuous ring; region of tergite almost invariably produced into a median simple or bifid lobe that is set with microscopic spicules; claws (male) toothed.... 13.
    Male hypopygium with ninth tergite and sternite separated by a suture or by pale membrane; region of tergite not produced, usually emarginate or notched; claws (male) toothed or simple.......................... 15.

13. Wings with m-cu usually close to fork of M; wings usually with a longitudinally striped or vittate pattern, but without a darkened cloud in cell Cu; squama naked .... 8. *Yamatotipula.*
 Wings with m-cu at or close to midlength of cell 1st M_2; wings rarely striped longitudinally (in a few *Acutipula*), if so, with a darkened cloud at near midlength of cell Cu; some species with a costal darkening (*Tipula*); squama usually with setæ (in local fauna)........ 14.
14. Outer veins of wing with trichia; costal border of wing darkened (many *Tipula*); no dark spot at near midlength of cell Cu.. 7. *Tipula.*
 Wings with outer veins glabrous or nearly so; no costal darkening; where suffused, with a dark spot at near midlength of cell Cu.
 9. *Acutipula.*
15. Wing veins almost without trichia, there being none on M or its branches; squama naked; sternopleurite and meron normally with setæ; claws simple .... 13. *Arctotipula.*
 Wing veins with evident trichia; squama naked or with a group of setæ; sternopleurite and meron glabrous; claws (male) toothed (in all local species, with the exception of a small number of *Oreomyza*).
 16.
16. Squama naked .... 17.
 Squama with a group of setæ.. 18.
17. Rs very short, only a little longer than r-m and not exceeding two-thirds the length of m-cu; R_{1+2} atrophied; m-cu some distance before fork of M_{3+4}, usually at near midlength.................... 11. *Papuatipula.*
 Rs elongate, subequal to or longer than m-cu; R_{1+2} usually preserved, more rarely atrophied; m-cu at or close to fork of M_{3+4}.
 15. *Oreomyza.*
18. Male hypopygium with the outer dististyle very large, equalling in size or exceeding the inner style; large species with marmorate wings; ovipositor with elongate valves, their margins smooth.
 3. *Sinotipula.*
 Male hypopygium with the outer dististyle small, cylindrical to depressed clavate; medium-sized species, usually with the wings plain or only weakly patterned; large species with marmorate wings (*marmoratipennis* group), the ovipositor with weak fleshy cerci.
 16. *Lunatipula.*

Species of Tipula not definitely assigned to subgenera (in parenthesis, a mere opinion of possible location for certain species is given).

1. *blastoptera* Alexander.
2. *brunnicosta* Brunetti. (*Lunatipula* or *Acutipula.*)
3. *conjuncta* Alexander. (*Tipula* or *Oreomyza.*)
4. *filicornis* Brunetti, *lackschewitziana* Alexander, *mitocera* Alexander, and probably *pullimargo* Edwards, all appear allied. (*Acutipula.*)
5. *flavicosta* Alexander. (*Schummelia* or *Indotipula.*)
6. *flavothorax* Brunetti. (*Indotipula* or *Oreomyza.*)
7. *formosicola* Alexander. (Looks like *Yamatotipula* or *Acutipula*, but male antenna very remarkable.)

8. *gressitti* Alexander.
9. *halteroptera* Edwards.
10. *hingstoni* Edwards.
11. *ligulifera* Alexander. (*Oreomyza* or *Yamatotipula.*)
12. *nigrocostata* Alexander and *sakaguchiana* Alexander. (*Yamatotipula* or *Oreomyza.*)
13. *nigrinervis* Edwards and *tjibodensis* Alexander.
14. *pluto* Brunetti. (Not *Formotipula.*)
15. *xanthomelæna* Edwards. (Probably not *Schummelia*, authority Edwards.)

Besides the above, a few species are known to me only from insufficient descriptions and I cannot place them at this time.

Species of Tipula known only from insufficient descriptions.

1. *flavescens* Brunetti. (*Indotipula.*)
2. *japonica* Loew.
3. *inordinans* Walker.
4. *parva* Loew. (*Schummelia.*)
5. *perelegans* Alexander (*elegans* Brunetti, preoccupied). (*Vestiplex* or *Oreomyza.*)
6. *schummeli* Brunetti (*longicornis* Doleschall, preoccupied).
7. *tropica* de Meijere.

Tipula (*Tipulina*) *breviceps* Motschulsky (Amur) evidently belongs in the subfamily Limoniinæ, but is unrecognizable.

The following species from this faunal area, described in the genus *Tipula*, pertain to the allied genus *Ctenacroscelis* Enderlein.

Species described in Tipula that belong in Ctenacroscelis.

borneensis Brunetti (*pallida* Walker, preoccupied).
brobdignagia Westwood.
carmichaeli Brunetti.
cinerea Brunetti. (very possibly).
congruens Walker.
dives Brunetti.
flava Brunetti.
flavoides Brunetti.
fulvolateralis Brunetti.
fumipennis Brunetti.
infindens Walker.
majestica Brunetti.
mikado Westwood.
monochroa Wiedemann.
novæ-guineæ de Meijere.
ochripes Brunetti.
ornatithorax Brunetti.
pilosula van der Wulp.
præpotens Wiedemann.
punctifrons Rondani.
serricornis Brunetti.
umbrina Wiedemann.

1. Subgenus BRITHURA Edwards

Brithura EDWARDS, Ann. & Mag. Nat. Hist. VIII 18 (1916) 262–263.
Tipula (*Brithura*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 76.
Tipula (*Brithura*) EDWARDS, Stylops 1 (1932) 240.

Type.—*Tipula imperfecta* Brunetti (as *Brithura conifrons* Edwards). (Eastern Palæarctic.)

Body stature stout, powerfully constructed, especially the abdomen.

Antennæ 13-segmented, relatively short in both sexes; flagellar segments with verticils of unusual length, these being three to five in number, all basal, two dorsal in position; terminal flagellar segment pointed at tip, about one-third the length of the penultimate. Frontal prolongation of head moderate in length; nasus distinct, simple. Anterior vertex produced into a simple, unusually slender tubercle. Ventral genæ with long coarse setæ.

No setæ on anepisternum; dorsal sternopleurite with many (*argyrospila* and *nymphica*), few (*sancta*), or no delicate setæ (some, *sancta, fracticosta, fractistigma,* and *imperfecta*). Coxæ with abundant long coarse setæ. Pleurotergal tubercle large and conspicuous, with dense plushlike pubescence on dorsal surface. Legs relatively stout; basitarsi shorter than tibiæ; tibial spur formula 1–1–2; claws (male) with small subbasal tooth. Wings with the costal region opposite the stigma often incrassated (especially in males), more or less arched, reaching its greatest development in males of *fracticosta* and *fractistigma* where the region is enlarged and broken by a double fracture that incloses a sharp tooth (Plate 1, fig. 2); posterior border of wing, opposite termination of vein Cu_1, shallowly emarginate. Squama with numerous setæ; veins beyond cord almost without trichia, there being a complete series only on R_{4+5}; more rarely with scattered trichia or incomplete series on M_{1+2}. Venation: Sc_1 present in males, weak or entirely lacking in most females, even in species (as *fractistigma*) where it is most powerfully developed in male; Rs strongly arcuated, subequal in length to m-cu; r-m variable in length, in cases short to completely obliterated by fusion of veins R_{4+5} and M_{1+2}; cell 1st M_2 pentagonal to high subrectangular; m-cu long, at fork of M_{3+4} or shortly before this fork (Plate 1, figs. 1, 2).

Male hypopygium (Plate 2, figs. 25, 26) large, the tergite entirely separated from the sternite; basistyle small and very narrow, almost completely fused with sternite. Ninth tergite with caudal margin notched. Ninth sternite strongly produced ventrad into a median carina or tubercle. Dististyle complex, the outer arm terminating in an acute spine that is directed caudad or dorsad, longest and most conspicuous in *nymphica* (among the species where the male sex is known). Ovipositor

with cerci long and straight, smooth-margined; hypovalvæ extending to shortly beyond midlength of cerci.

Figures of venation and male hypopygia of the various species include the following:

crassa EDWARDS, Ann. & Mag. Nat. Hist. VIII 18 (1916) pl. 12, fig. 12.
fractistigma ALEXANDER, Ann. & Mag. Nat. Hist. IX 15 (1925) 387.
imperfecta BRUNETTI (as *conifrons* Edwards), Ann. & Mag. Nat. Hist. VIII 18 (1916) pl. 12, figs. 10, 11; ALEXANDER, Philip. Journ. Sci. 40 (1929) pl. 1, fig. 2.
nymphica ALEXANDER, Proc. U. S. Nat. Mus. 72 art. 2 (1927) fig. 1.
sancta ALEXANDER, Philip. Journ. Sci. 40 (1929) pl. 1, fig. 1.

The known species are all from eastern Asia, ranging from Formosa and eastern China to western China and the Himalayan region. Present information seems to indicate that the adult flies appear in late summer and autumn.

Species of the subgenus Brithura.

1. PALÆARCTIC EASTERN ASIA

imperfecta Brunetti (*conifrons* Edwards.)
sancta Alexander.

2. PALÆARCTIC CENTRAL ASIA

argyrospila sp. nov.
crassa Edwards (*gravelyi* Brunetti).
fractistigma Alexander.
imperfecta Brunetti (see 1).
nymphica Alexander.
sancta Alexander (see 1).

TIPULA (BRITHURA) ARGYROSPILA sp. nov. Plate 1, fig. 1.

Allied to *nymphica;* size very large (female, length over 40 millimeters); antennal flagellum light yellow; flagellar segments each with five verticils; tip of vertical tubercle polished yellow; pleurotergal tubercle with dorsal surface silvery; femora yellow, the tips conspicuously black; wings pale yellow, variegated by light and darker brown; prearcular region conspicuously pale yellow; vein Sc_1 atrophied; abdominal tergites deep orange, the outer lateral angles of the segments not brightened; sternites darker brown; ovipositor with shield deep red.

Female.—Length, about 43 to 45 millimeters; wing, 30 to 31.

Frontal prolongation of head dark reddish brown. Antennæ with scape dark brown; pedicel reddish brown; flagellum light yellow; flagellar segments each with five verticils. Head dark brown, the front and orbits narrowly paler; extreme point of vertical tubercle polished yellow.

Mesonotal præscutum and scutum rich cinnamon-brown, the mediotergite darker. Pleura chiefly dark brown, variegated by the conspicuous silvery dorsal surface of the pleurotergal tubercle; dorsopleural membrane broadly yellow. Legs with the femora yellow, the tips conspicuously black; tibiæ yellow, the tips rather narrowly infuscated; tarsi yellowish brown. Wings (Plate 1, fig. 1) pale yellow, variegated by light and darker brown; prearcular region conspicuously pale yellow; cells C and Sc more brownish yellow; stigma orange-yellow, surrounded by a yellow suffusion extending back to cell 1st M_2; wing tip and anal cell almost uniformly darkened, only sparsely variegated by yellow spots; outer medial field very pale, the color involving vein M_3; dark spots at origin of Rs, in cell Cu and at arculus small but conspicuous. Venation: Sc_1 atrophied; R_2 punctiform; cell 1st M_2 pentagonal, the outer end somewhat pointed; m-cu at fork of M_{3+4}.

Abdominal tergites deep orange, the posterior borders of outer segments narrowly pale; sternites darked brown. Ovipositor with the valves and shield deep red; hypovalvæ dark.

Habitat.—China (Szechwan).

Holotype, female, Fu-Lin, altitude 3,800 to 8,200 feet, 1928 (*Graham*). Paratopotype, female.

This fly is similar to the much smaller *Tipula* (*Brithura*) *nymphica* (Alexander), which must be considered as being its nearest ally. The characters available for separating the various Chinese species of *Brithura* are indicated in the accompanying key.

Key to the Chinese species of Brithura.

1. Vein Sc_1 lacking (in most females) .... 2.
   Vein Sc_1 present (chiefly in males) .... 4.
2. Femora darkened, with a yellow subterminal ring...... *sancta* Alexander.
   Femora yellow, the tips conspicuously blackened .... 3.
3. Vertical tubercle uniformly darkened; size medium (wing, female, less than 25 millimeters); outer lateral angles of basal abdominal tergites pale .... *nymphica* Alexander.
   Tip of vertical tubercle polished, light yellow; size very large (wing, female, about 30 millimeters); tergites uniformly orange, the outer lateral angles not pale .... *argyrospila* sp. nov.
4. Femora unmarked or only with a faintly darker subterminal ring. *imperfecta* Brunetti.
   Femora with the tips broadly and conspicuously blackened .... 5.
5. Wings (male) with costal border opposite stigma broken and toothed (Plate 1, fig. 2) .... 6.
   Wings with costal border unbroken in either sex (Plate 1, fig. 1) .... 7.

6. Pleura dark brown, unvariegated except by the pale dorsal surface of the pleurotergal tubercle; antennal flagellum brownish yellow; male hypopygium with the spine of dististyle large and conspicuous. *fracticosta* sp. nov.

   Pleura reddish brown, variegated with silvery, additional to the pale pleurotergal tubercle; antennal flagellum uniformly dark brown; male hypopygium with outer spine of dististyle small and weak. *fractistigma* Alexander.

7. Abdominal tergites reddish brown; femora yellow, the tips black. *nymphica* Alexander.

   Abdominal tergites brownish black; femora brown, the tips black, preceded by a yellow subterminal ring.............................. *sancta* Alexander.

TIPULA (BRITHURA) IMPERFECTA Brunetti.

Tipula imperfecta BRUNETTI, Rec. Indian Mus. 9 (1913) 260–261.
Brithura conifrons EDWARDS, Ann. & Mag. Nat. Hist. VIII 18 (1916) 262–263.

The types of the above names were from the eastern Himalayas and Formosa, respectively. The species had not been recorded previously from any intermediate station.

Kwanhsien, Szechwan, altitude 3,000 feet, August 16, 1930 (*Franck*). Mount Omei, Szechwan, altitude 5,500 to 10,800 feet, August 16 to 20, 1934 (*Graham*).

TIPULA (BRITHURA) FRACTICOSTA sp. nov. Plate 1, fig. 2; Plate 2, fig. 25.

Allied to *fractistigma;* antennal flagellum brownish yellow to pale brown; thoracic pleura dark brown, scarcely variegated except for the silvery dorsal surface of the pleurotergal tubercle; legs dark, the femora with a yellow subterminal ring; wings (male) with the costa broken opposite the stigma; male hypopygium with a dense brush of setæ on basistyle; spine of dististyle long and conspicuous.

Male.—Length, about 28 to 30 millimeters; wing, 22 to 24.

Frontal prolongation of head dark brown; nasus stout but distinct; palpi brownish black. Antennæ with scape and pedicel light brown, the flagellum more brownish yellow to pale brown. Head dark brown, the sides of the vertical tubercle and posterior orbits paler.

Pronotum and mesonotum dark brown, the pronotal scutellum obscure yellow. Pleura almost uniformly dark brown; dorsopleural membrane obscure yellow. Pleurotergal tubercle with dense silvery pubescence on dorsal surface. Halteres dark brown, the apices of the knobs pale. Legs with the coxæ and trochanters dark brown to almost black; femora narrowly obscure yellow at base, thence strongly blackened, the tip black, preceded by a subequal yellow ring; tibia brown, the base nar-

rowly pale, the tip narrowly and weakly darkened; tarsi brownish black. Wings (Plate 1, fig. 2) strongly yellow, the prearcular and anterior portions clearer yellow; stigma and surrounding portions strongly saturated; a sparse dark and paler brown pattern; outer halves of cells R_2 and R_3 darkened; bases of all outer medial cells restrictedly infuscated; a broad seam on m-cu and adjoining portions of vein Cu_1; bases of cells R and M darkened; weak longitudinal clouds in cells R and M; veins yellow. Costal border of wing thickened, strongly bulging opposite stigma and here distinctly broken and interrupted by a sharp spur. Venation: Sc_1 strong, much longer than Sc_2; r-m obliterated by fusion of veins R_{4+5} and M_{1+2}, the distal section of the latter vein strongly sinuous; cell 1st M_2 unusually high, subrectangular in outline, the longest elements being the basal section of M_{1+2} and m; vein M_4 strongly arcuated.

Abdomen dark brown, the outer lateral angles of the segments restrictedly pale; hypopygium dark. Male hypopygium (Plate 2, fig. 25) with the caudal border of tergite, *9t*, deeply emarginate medially, the base of the notch with setæ, the lateral lobes with more abundant and conspicuous copper-colored setæ. Basistyle much reduced, with a dense brush of burnished setæ. Dististyle, *d*, as figured; outer spine large, the apical blade narrow. Tubercle of the ventrally produced ninth sternite, *9s*, moderately developed.

Habitat.—China (Szechwan).

Holotype, male, Lin-Ngai-Si, near Kwanhsien, altitude 3,500 feet, September 20, 1930 (*Graham*). Paratype, male, Ginfŭ-Shan, District Nanchŭan, August, 1929–1931 (*Friedrich*).

I am referring the Nanchŭan specimen here with some doubt, as the pleura is different in color from that of the type, the dorsal sternopleurite, ventral pteropleurite, and most of the meron being pruinose with gray, contrasting with the remainder of pleura. The relationship with *fractistigma* (dististyle, Plate 2, fig. 26, *d*) is shown by the key provided at this time.

2. Subgenus NIPPOTIPULA Matsumura

Nippotipula MATSUMURA, Thousand Ins. Japan, Add. 2 (1916) 457–458.

Tipula (*Nippotipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 77.

Tipula (*Nippotipula*) EDWARDS, Stylops 1 (1932) 238.

Type.—*Tipula coquilletti* Enderlein (as *Nippotipula nubifera* Coquillett by Matsumura). (Eastern Palæarctic.)

Antennæ 13-segmented, relatively short in both sexes; verticils exceeding the segments in length; terminal flagellar segment more than one-half as long as the penultimate. Vertical tubercle low and poorly developed.

Scutal lobes each with two darkened areas that are ringed with pale color. Setæ on propleura and sides of pronotal scutellum, as well as on the sternopleurite and more sparsely on anepisternum. Mesonotal interspaces with relatively abundant setæ that are long and conspicuous, especially on the scutellum and mediotergite. Pleurotergal tubercle moderately developed. Tibial spur formula 1–2–2; claws (male) toothed. Wings with Rs very long, fully twice m-cu, the latter close to midlength of cell 1st M_2 and almost always uniting with M_{3+4} some distance before its fork; in rarer cases, m-cu close to fork of M_{3+4} (*phædina*); Rs in direct alignment with R_{4+5}, the basal deflection of the latter lacking. Squama with a group of setæ; M and branches naked or with sparse trichia.

Abdomen long to very long especially in *coquilletti* and *sinica*. Male hypopygium with suture between ninth tergite and sternite complete; basistyle cut off from sternite only by ventral suture. Outer dististyle very large and depressed; inner style unusually small. Eighth sternite produced caudad into a profoundly bifid median lobe. Ovipositor with smooth cerci; hypovalvæ well developed.

Species of the subgenus Nippotipula.

1. PALÆARCTIC EASTERN ASIA

coquilletti Enderlein (*nubifera* Coquillett, preoccupied).
sinica sp. nov.

2. PALÆARCTIC CENTRAL ASIA

phædina Alexander.
pulcherrima Brunetti.
sinica sp. nov. (see 1).
susurrans Edwards.

3. ORIENTAL EASTERN ASIA

anastomosa Edwards.
xanthostigma Edwards.

TIPULA (NIPPOTIPULA) SINICA sp. nov. Plate 1, fig. 3; Plate 2, fig. 27.

Very closely allied to *coquilletti*, differing in the usually smaller size, more-slender build, less extensively darkened median præscutal stripe, and the chiefly black legs, especially the fore pair.

Male.—Length, 30 to 33 millimeters; wing, 21 to 23; abdomen alone, 22 to 23.

Female.—Length, 35 to 36 millimeters; wing, 22 to 23; abdomen alone, 28 to 29.

Frontal prolongation of head brown, light gray pruinose above; nasus distinct; palpi brownish black, the terminal segment beyond base somewhat paler. Antennæ with basal segment brown; pedicel yellow; basal flagellar segment brownish yellow, the succeeding segments dark brown with their basal enlargements a trifle darker; longest verticils exceeding the segments. Head light gray, the genæ darker.

Pronotum whitish gray, slightly darker medially. Mesonotal præscutum whitish gray, with three stripes, the median stripe chiefly dark gray, the outer borders conspicuously velvety black on cephalic half or less; lateral stripes chiefly velvety black, paling to gray behind; humeral region immediately before the lateral stripes more or less darkened; each scutal lobe with two velvety black spots that are narrowly bordered by light gray, the median region of the scutum slightly darker gray; scutellum brownish gray, the sunken parascutella darker; mediotergite gray, variegated laterally and behind with darker, the latter pattern consisting of two circular areas; in cases a more or less distinct median dark line on scutellum and mediotergite. Pleura silvery gray with a broad brown dorsal stripe extending from the cervical region to the pleurotergite, where it becomes a little paler; extreme ventral sternopleurite and dorsal meron darkened. Halteres dark brown, the base of stem narrowly pale. Legs with the fore coxæ brownish gray, narrowly dark brown at base middle coxæ gray, narrowly darkened at posterior border; posterior coxæ chiefly dark brown, the outer end gray; trochanters chiefly dark brown; legs chiefly black, especially the fore pair; femoral bases restrictedly pale, broadest and most conspicuous on posterior legs. Wings (Plate 1, fig. 3) with the pattern almost as in *coquilletti*, differing only in slight details; ground color whitish, with darker washes and two major clouds, the latter at origin of Rs and in the stigmal region; outer radial field less strongly suffused, especially in outer end of cell R_3; a series of dark marginal spots at ends of all outer longitudinal veins; veins brown, paler in costal field. Venation: Rs shorter than in *coquilletti*.

Abdomen chiefly yellow; first tergite dark with a median yellow line; succeeding tergites with the margins pale, the subcaudal borders very narrowly blackened; a black median tergal

stripe begins on the third segment, becoming broader and more diffuse behind; lateral borders of tergites narrowly grayish; hypopygium more uniformly darkened. Male hypopygium (Plate 2, fig. 27) with the tergite, *9t*, separated from the sternite, *9s*, by a suture; basistyle chiefly fused with sternite, represented by a weak ventral suture, the posterior end of style produced into a short broad truncated lobe. Ninth tergite, *9t*, greatly arched, the caudal margin with two blackened lobes that are set with black spinulæ. Eighth sternite, *8s*, produced into a broadly flattened, shovellike lobe that is profoundly split, each lateral lobe relatively broad.

Habitat.—China.

Holotype, male, Hills near Ning-po, halfway to Nimrod Sound, Che kiang, May 1, 1925 (*Suenson*). Allotopotype, female. Paratopotype, male. Paratypes, males and females, Kwanhsien, Szechwan, 2,000 to 4,000 feet, May 8 to 28, 1930 (*Graham*); females, Chengtu, Szechwan, altitude 1,700 feet, April 1 to 10, 1933 (*Graham*).

While the present fly is closely allied to *Tipula* (*Nippotipula*) *coquilletti* Enderlein, there seems to be little question of its distinctness.

3. Subgenus SINOTIPULA novum

Type.—*Tipula exquisita* sp. nov. (Eastern Palæarctic.)

Antennæ 13-segmented; verticils very long and conspicuous, fully one-half longer than the segments; terminal segment about one-half as long as the penultimate. Frontal prolongation of head long; nasus distinct. Vertical tubercle low and merely protuberant.

No setæ on mesopleura. Coxæ with abundant long setæ. Pleurotergal tubercle not or scarcely evident. Legs relatively long and slender; basitarsi a little shorter than the tibiæ; tibial spur formula 1–1–2; claws (male) with subbasal tooth. Squama and veins with trichia. Wings with outer section of vein R_1 unusually long, much longer than the free tip of Sc_2; R_{1+2} entire; vein R_3 more or less sinuous, somewhat constricting cell R_3 at near midlength; basal section of R_{4+5} long and distinct; Rs long to very long, from one and one-half to more than two times as long as m-cu; m-cu at or very close to fork of M_{3+4}, unusually long, so cell M_4 is markedly wider at base.

Male hypopygium (Plate 2, fig. 28–31) with tergite and sternite separated by a suture. Tergite large and tumid, often

with two rounded lobes on caudal portion; in some species (including the subgenotype) with complex sclerotized armature on ventral surface. Outer dististyle very large, equaling or exceeding in area and complexity the relatively small inner style. Ovipositor with cerci long and relatively slender, the margins smooth.

Points of contact.—The subgenera most apt to be confused are *Brithura, Nippotipula,* and *Lunatipula,* all of which have similar groups of setæ on the squamæ and include members of large size and of showy coloration. *Brithura* is readily told by the slender conical vertical tubercle; *Nippotipula* by the lack of the basal section of R_{4+5} and the position of m-cu far before the fork of M_{3+4}. Some of the groups that I have referred to *Lunatipula,* especially the *marmoratipennis* group, bear a general resemblance to the present aggregation of species yet are quite distinct in the structure of the ovipositor and other characters.

Species of the subgenus Sinotipula.

2. PALÆARCTIC CENTRAL ASIA

bodpa Edwards.
brunettiana Alexander (*splendens* Brunetti, preoccupied).
cranbrooki Edwards.
exquisita sp. nov.
gloriosa sp. nov.
gregoryi Edwards.
griseipennis Brunetti.
hobsoni Edwards.
persplendens sp. nov.
sindensis Alexander.
tessellatipennis Brunetti.
thibetana de Meijere.
trilobata Edwards.
waltoni Edwards.
wardi Edwards.

I had earlier called all of these the *thibetana* group, but it now seems that *exquisita, gregoryi, hobsoni,* and *waltoni* may well be separated as a distinct group, the *gregoryi* group, based chiefly on conspicuous modifications of the ninth sternite of the male hypopygium.

TIPULA (SINOTIPULA) EXQUISITA sp. nov. Plate 1, fig. 4; Plate 2, fig. 28.

Belongs to the *gregoryi* group, allied to *gregoryi;* head above light gray; wings pale brown, variegated by darker brown and cream-colored areas; prearcular region chiefly pale, the arcular transverse band ill-defined; male hypopygium with two pairs of lobes on ninth sternite, projecting caudad, the more dorsal pair clothed with long yellow setæ.

Male.—Length, 19 to 22 millimeters; wing, 22 to 25.

Female.—Length, 22 to 24 millimeters; wing, 24 to 26.

Frontal prolongation of head reddish brown, a little darker on sides; nasus elongate; palpi dark brown, terminal segment black. Antennæ with scape and pedicel yellow; flagellum brownish black; longest verticils a little exceeding the segments. Head above light gray, with vague indications of a darker median vitta; genæ darker; a darkened spot above each antennal fossa, as in *gregoryi.*

Pronotum dark medially, broadly yellow on sides. Mesonotal præscutum brownish yellow with four slightly indicated brighter brown stripes, the intermediate pair scarcely separated by a median vitta; humeral and lateral margins a little darkened; scutal lobes brown; scutellum brownish gray; mediotergite clearer gray. Pleura dark brown, variegated with silvery on dorsal sternopleurite and meron; dorsopleural region light yellow. Halteres with stem obscure yellow, brighter at base; knobs darkened basally, the tips paler. Legs with the coxæ dark gray; trochanters yellowish brown; femora obscure yellow, the tips black; tibiæ and basitarsi yellow, the tips narrowly darkened; remainder of tarsi black. Wings (Plate 1, fig. 4) with a pale brown tinge, variegated by darker brown and sparse cream-colored areas, the ground color much paler than in *gregoryi,* but the pattern arranged much the same; arcular pale band incomplete, best indicated in cell 2d A, in the arcular region more diffuse due to a general paling of the prearcular field. Wings shorter and broader than in *gregoryi;* cell 1st M_2 proportionately smaller.

Abdomen (male) with basal six segments reddish yellow, without distinct markings; outer abdominal segments black. In female the tergites striped laterally with dark brown. Male hypopygium (Plate 2, fig. 28) with the tergite, *9t,* having the caudal border weakly emarginate, clothed with abundant coarse setæ; on ventral surface of tergite (as figured) a transversely quadrate sclerotized plate that is conspicuously armed with large spines at each angle of the plate; dorsal border of this tergal plate with three smaller, slenderer spines. Dististyle, *d,* complex, as figured. From the mesal-caudal portion of the sternite, *9s,* protrude two pairs of conspicuous appendages; the more dorsal pair are fleshy lobes that are densely tufted with yellow setæ; the more-ventral appendages appear as compressed blades, their margins with parallel striæ. Ovipositor with short, stout cerci.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, Yin-Kuan-Tsai, altitude 13,000 to 15,000 feet, July 25, 1930 (*Graham*). Allotype, female, Yu-Long-Gong, altitude, 14,000 feet, August 14, 1930 (*Graham*). Paratopotypes, 4 males. Paratypes, 1 male, 1 female, Zya-Ha Pass, altitude 14,000 to 17,000 feet, July 25 to 27, 1930; 1 male, near Tang-Gu, altitude 14,000 feet, August 3 to 6, 1930; 1 male, near Yien-Long-Shien, altitude 13,000 to 15,000 feet, August 3 to 6, 1930 (*Graham*).

The nearest allies of the present fly are *Tipula* (*Sinotipula*) *gregoryi* Edwards (Yunnan, Szechwan) and *T.* (*S.*) *waltoni* Edwards (Tibet), both of which differ especially in the details of coloration of the body and wings.

TIPULA (SINOTIPULA) GLORIOSA sp. nov. Plate 1, fig. 5; Plate 2, figs. 29 and 30.

Belongs to the *thibetana* group; allied to *trilobata;* mesonotum brownish yellow, with four conspicuous brown stripes; lateral margins of præscutum further darkened; antennal flagellum black; femora brownish yellow, the tips very narrowly to scarcely darkened; wings brown, tessellated with yellow; male hypopygium with the outer dististyle larger than the inner.

Male.—Length, about 18 millimeters; wing, 20.

Frontal prolongation of head brownish gray; nasus conspicuous; palpi dark brown, in the paratype female with the intermediate segments conspicuously light yellow. Antennæ of moderate length to short, in male, if bent backward, not quite reaching the wing root; scape brownish yellow; pedicel and base of first flagellar segment yellowish brown; remainder of flagellum black, the basal enlargements of the segments a little more protuberant on outer face so the flagellar segments appear slightly irregular in their alignment. Head brownish gray, clearer gray on front and anterior vertex; a narrow black vitta from summit of anterior vertex to the occiput.

Pronotal scutellum chiefly black, obscure yellow behind. Mesonotal præscutum with the ground color brownish yellow, with four conspicuous brown stripes, the intermediate pair approximated or narrowly contiguous at extreme cephalic end; lateral portions of præscutum before suture narrowly black, behind the suture more extensively dark brown; humeral region between the lateral and intermediate stripes washed with dusky; scutum

grayish yellow, each lobe variegated by a large brown area; scutellum light gray, with a median brown vitta, more evident in female; mediotergite grayish brown. Pleura chiefly pale, with brown longitudinal areas, including a dorsal stripe; dorsopleural region conspicuously yellow. Halteres yellow, the base of each knob dusky. Legs with the coxæ brown; trochanters yellowish brown; femora, tibiæ, and basitarsi brownish yellow, the extreme tips blackened; remainder of tarsi black. Wings (Plate 1, fig. 5) rather dark brown, conspicuously variegated with yellow, more contrasted in female than in male; prearcular region chiefly infumed; cell C brownish yellow, cell Sc clear yellow; the yellow discal areas appear as zigzag crossbands over the basal cells of wing, beyond the cord appearing as an incomplete crossband beyond stigma, not reaching cell 1st M_2, and as pale triangular spots in outer ends of cells R_3 to M_4, inclusive, more extensive in cell R_5 where nearly the outer end is pale; cubital and anal cells more conspicuously variegated by the zigzag areas above mentioned; a more whitish obliterative band across cord, from cell R to base of cell M_3; veins dark, more yellowish in the flavous areas. Venation: R_{1+2} preserved; R_3 arched, somewhat constricting cell R_3 at near midlength; m-cu very long, cell M_4 much wider at base than at apex.

Abdomen with basal tergite infuscated; succeeding tergites obscure yellow, beyond the second darkened sublaterally at base, the lateral borders broadly pale; sternites chiefly yellow; outer segments and hypopygium passing into black. Male hypopygium (Plate 2, fig. 29) large and rounded, without conspicuously projecting appendages; the tergite, *9t*, with two low glabrous lobes on caudal portion, the arched dorsal portion with long conspicuous black setæ. Dististyles (Plate 2, fig. 30, *od, id*) as shown, the inner much smaller than the outer, with a small pale appendage near its apex, the actual tip stout.

Habitat.—China (Szechwan).

Holotype, male, Wei-Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*). Allotype, broken female, O-Er, 26 miles north of Li-Fan, altitude 10,800 feet, August 16, 1933 (*Graham*). Paratopotype, broken female, with holotype.

The present fly and the one next described are closely related, being apparently most nearly allied to *Tipula* (*Sinotipula*) *trilobata* Edwards among the described forms, differing conspicu-

ously in the coloration of the thorax and abdomen, and in genitalic structures.

TIPULA (SINOTIPULA) PERSPLENDENS sp. nov. Plate 2, fig. 31.

Belongs to the *thibetana* group; allied to *gloriosa;* mesonotal præscutum obscure yellow, with four reddish brown stripes that are very narrowly bordered by darker; antennal flagellum brownish black; femora yellow, the tips very narrowly and insensibly darkened; wings pale brown, variegated and tessellated with pale yellow and darker brown areas; outer medial cells with centers washed with pale brown; basal abdominal segments reddish brown, the outer segments darkened; male hypopygium with the inner dististyle bifid at apex, the beak slender.

Male.—Length, about 25 millimeters; wing, 27.

Female.—Length, about 27 millimeters; wing, 27.

Frontal prolongation of head elongate, brown, the dorsum light gray pruinose; nasus distinct; palpi brown, the elongate outer segment brownish black. Antennæ relatively short, in male, if bent backward not quite attaining the wing root; scape yellow; pedicel and first flagellar segment brownish yellow; remainder of organ brownish black. Head light gray with a continuous, dark brown, median stripe from summit of vertex to occiput.

Pronotum dark brown medially, paler on sides. Mesonotal præscutum obscure yellow, with four reddish brown stripes that are very narrowly and irregularly bordered by brown, more evident on the lateral stripes and cephalic portions of the intermediate stripes; a dusky line across the humeral region, from the intermediate stripe caudad; lateral border of sclerite before the suture strongly darkened; median region of præscutum adjoining the suture narrowly bordered by dark brown; scutal lobes reddish brown, paler medially and narrowly silvery adjoining the suture, with a dusky mark on mesal edge behind; scutellum and mediotergite gray laterally, brown medially. Pleura pale, conspicuously variegated by dark brown, including a dorsal stripe extending from the cervical region across propleura, ventral anepisternum, and ventral pteropleurite; ventral sternopleurite and meron darkened; dorsopleural region light yellow. Halteres yellow, the knobs infuscated, the apex a little paler. Legs with the coxæ gray, narrowly darkened at base; trochanters brownish yellow; femora and tibiæ yellow, the tips very narrowly and insensibly darkened; tarsi black, the proximal

end of basitarsus brightened. Wings with the ground color rather pale brown in both sexes, variegated by extensive pale yellow areas and more restricted darker brown markings; the darker brown areas include a relatively small postarcular darkening that is more extensive in cell Cu; a very small spot at origin of Rs, and the stigmal darkening; the ground areas of paler brown appear as extensive zigzag clouds across the basal half of wing, restricting the yellow to narrow lines; beyond the cord the centers of the outer medial cells are washed with very pale brown, at margin inclosing a clear yellow spot; dark area in cell R_5 much restricted; poststigmal yellow area extensive; veins pale brown, C, Sc, R, and outer half of Cu clearer yellow. Venation: m-cu very long.

Basal three abdominal tergites reddish brown, the succeeding segments somewhat darker, in male more or less pruinose, in female with caudal borders of the segments narrowly yellow; basal sternites reddish brown, the outer segments darker. Male hypopygium in general somewhat similar to that of *gloriosa;* caudal margin of tergite terminating in two low rounded lobes, the notch between small and circular; tergal lobes with setæ almost to outer ends; dorsal posterior portion of tergite with numerous setæ. Dististyles (Plate 2, fig. 31, *od, id*) as figured; inner style at apex split into two slender lobes, the darker-colored one being the usual beak; outer style very obtuse in its outlines, on its cephalic margin at near midlength with a flattened, sclerotized plate.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, near Tang-Gu, altitude 14,000 feet, August 3 to 6, 1930 (*Graham*). Allotype, female, Yin-Kuan-Tsai, altitude 13,000 to 15,000 feet, July 25, 1930 (*Graham*).

The nearest ally of the present fly is *Tipula* (*Sinotipula*) *gloriosa* sp. nov., which is readily told by the different wing pattern and structure of the male hypopygium.

4. Subgenus TRICHOTIPULA Alexander

Tipula (*Trichotipula*) ALEXANDER, Proc. Acad. Nat. Sci. Philadelphia **67** (1915) 468.

Tipula (*Cinctotipula*) ALEXANDER, Proc. Acad. Nat. Sci. Philadelphia **67** (1915) 469.

Tipula (*Odontotipula*) ALEXANDER, Cornell Univ. Agr. Exp. Sta. Mem. **38** (1919) 943.

Type.—Tipula oropezoides Johnson. (Eastern Nearctic.)

Antennæ short to elongate (in male); verticils present but usualy shorter than the segments. Frontal prolongation of head short to very short, much as in *Dolichopeza;* nasus long and slender.

Halteres elongate. Legs long and slender; tibial spur formula 1–2–2; claws (male) with basal tooth. Squama naked; all longitudinal veins with trichia, almost, if not quite, to wing base; abundant trichia in outer cells of wing, most numerous in *polytricha* where virtually the entire wing surface is covered. Venation: R_{1+2} entire; Rs short, subequal to m-cu; m-cu on M_{3+4} shortly beyond fork of M, the former thus being short to almost lacking; cell M_4 deep, widened at proximal end, m-cu being oblique to very oblique.

Male hypopygium of simple construction; posterior margin of ninth sternite more or less produced caudad into a fleshy lobe. Ovipositor with cerci sclerotized, compressed-flattened, the tips obtuse, considerably exceeding the hypovalvæ.

Species of the subgenus Trichotipula.

1. Palæarctic Eastern Asia. *haplotricha* Alexander.
2. Palæarctic Central Asia. *polytricha* Alexander.

5. Subgenus SCHUMMELIA Edwards

Tipula (*Schummelia*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 80–81.

Type.—Tipula variicornis Schummel. (Northern Palæarctic.)

Antennæ (male) often elongate; verticils long, subequal to or exceeding the segments except in the species with elongate antennæ; terminal segment reduced to a thimble-shaped structure. Frontal prolongation of head short to very short; nasus conspicuous.

Mesopleura glabrous. Tibial spur formula 1–2–2; claws (male) with basal tooth. Squama with abundant setæ; all veins beyond cord with numerous macrotrichia; some species (*macrotrichiata* group) with sparse macrotrichia in outer cells. Venation: R_{1+2} entire; Rs relatively short, subequal to the long m-cu; cell M_4 deep and markedly wider at base than at margin; m-cu very oblique, variable in position, often placed near base of the small or medium-sized cell 1st M_2, in other cases at near midlength of the cell, close to the fork of M_{3+4}; M_4 in direct

alignment with M_{3+4}; m often reduced in length by the approximation of veins M_{1+2} and M_3; Cu_1 without a distinct constriction or shirring at point of insertion of m-cu.

Male hypopygium with tergite and sternite separate, or fused on extreme cephalic portion only. Median region of tergite produced into a compressed blade (*variicornis* subgroup) or notched medially (*continuata* subgroup). Outer dististyle elongate but compressed. Inner dististyle a flattened blade, on cephalic margin produced into a slender beak. Eighth sternite unarmed. Ovipositor with long, straight, very slender cerci; hypovalvæ elongate, compressed, longer than the cerci.

The three groups in the local fauna have been briefly discussed in another paper.[3] The present subgenus and *Trichotipula* must be very close to the ancestral type of the genus *Dolichopeza*.

Species of the subgenus Schummelia.

1. PALÆARCTIC EASTERN ASIA

acifera Alexander.
bidenticulata Alexander.
cylindrostylata Alexander.
ecaudata Alexander.
esakiana Alexander.
imanishii Alexander.
insulicola Alexander.
i. fuscicauda Alexander.
jocosipennis Alexander.
macrotrichiata Alexander.
microcellula Alexander.
nikkoensis Alexander.
nipponensis Alexander.
querula Alexander.
rantaicola Alexander.
sparsiseta Alexander.
sparsissima Alexander.
strictiva Alexander.
variicornis Schummel.
v. latiligula Alexander.

2. PALÆARCTIC CENTRAL ASIA

angustiligula Alexander.
chumbiensis Edwards.
continuata Brunetti.
honorifica Alexander.
indifferens Alexander.
indiscreta Alexander.
nigrocellula Alexander.
sessilis Edwards (*demarcata* Brunetti, preoccupied).
xanthopleura Edwards.

3. ORIENTAL EASTERN ASIA

hampsoni Edwards.
inconspicua de Meijere.
klossi Edwards.
pendleburyi Edwards.
picticornis (Brunetti).
pumila de Meijere.
rhombica Edwards.
salakensis Alexander (*robinsoni* Edwards).
vitalisi Edwards.

[3] Alexander, Philip. Journ. Sci. 51 (1933) 374.

6. Subgenus FORMOTIPULA Matsumura

Formotipula MATSUMURA, Thousand Ins. Japan, Add. 2 (1916) 456–457.

Tipula (*Formotipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 77.

Type.—*Formotipula holoserica* Matsumura. (Eastern Palæarctic.)

Antennæ of moderate length, the verticils exceeding the segments. Frontal prolongation of head short; nasus short but distinct; palpi elongate.

No setæ on mesopleura; on notum sparse and erect. Tibial spur formula 1–1–2; claws (male) toothed. Squama naked; trichia of outer medial branches variable in number, sometimes much reduced, in the subgenotype relatively numerous. Venation: R_{1+2} preserved (*dikchuensis, friedrichi, holoserica, hypopygialis, luteicorporis, melanomera, melanopyga, rufizona, rufoabdominalis,* and *sciariformis*), normally lacking or more or less atrophied in the remaining species; Rs of moderate length, subequal to or much shorter than m-cu; fork of M_{3+4} close to midlength of cell 1st M_2, m-cu at or just beyond this fork; cell M_4 short and broad, m-cu being only a little shorter than the distal section of Cu_1.

Abdomen short and compact, in male with hypopygium strongly tilted upward. Male hypopygium with the tergite separated from the sternite by a suture or, in cases (as in *friedrichi*), with the suture obsolete or virtually so, the tergite being fused with the sternite. Ninth tergite either notched medially or with a more or less distinct, beaklike, median projection (*friedrichi, holoserica,* and others). In cases basistyle more or less produced at apex into a fleshy lobe that is sometimes set with spinous points. Dististyle single, usually complicated in structure. Eighth sternite unarmed. Ovipositor with both cerci and hypovalvæ greatly reduced in size, fleshy.

The included species are medium-sized to relatively large flies, with highly contrasted coloration, the thorax either velvety black or reddish orange, contrasting strongly with the opposite color elsewhere on the body. Abdomen usually bicolorous, the basal portion reddish, the apex blackened. Edwards reports some variation in the presence or absence of vein R_{1+2} in *melanomera* and possibly in other species.

Species of the subgenus Formotipula.

1. PALÆARCTIC EASTERN ASIA

holoserica **Matsumura (*nigrorubra*** **Riedel, *rufomedia*** **Edwards).**
kiangsuensis Alexander.

2. PALÆARCTIC CENTRAL ASIA

dikchuensis Edwards.
exusta Alexander.
friedrichi sp. nov.
hypopygialis Alexander.
luteicorporis Alexander.
melanomera Walker.
obliterata Alexander.
omeicola sp. nov.
rufizona Edwards.
rufoabdominalis Alexander (*rufiventris* Brunetti, preoccupied).

3. ORIENTAL EASTERN ASIA

cinereifrons de Meijere.
dusun Edwards.
laosica Edwards.
lipophleps Edwards.
melanopyga Edwards.
sciariformis Brunetti.

Tipula pluto Brunetti (French Indo-China: Tonkin) cannot belong to *Formotipula,* as stated by Edwards (1932), because of the structure of the ovipositor.

TIPULA (FORMOTIPULA) OMEICOLA sp. nov. Plate 1, fig. 6.

Head and thorax velvety black, the præscutum with indications of four faintly gray stripes; wings strongly tinged with black; R_{1+2} entirely atrophied; cell 1st M_2 relatively large; abdomen black, with segments two to five, inclusive, orange-yellow.

Female.—Length, about 13 milimeters; wing, 14.

Entire head black; nasus short but distinct. Antennæ and palpi black.

Thorax velvety black, the præscutum with indications of four faintly gray stripes, the intermediate pair separated by a line of the ground color that is a little wider than either stripe; posterior sclerites of notum sparsely pruinose. Pleura black. Halteres and legs black throughout. Wings (Plate 1, fig. 6) strongly tinged with blackish, the oval stigma darker brown; veins dark brown. Venation: R_{1+2} entirely atrophied; cell 1st M_2 of moderate length, much larger than in *obliterata;* second section of M_{1+2} longer than the third section (petiole of cell M_1).

Abdomen with the first segment black; segments two to five, inclusive, entirely orange-yellow; remaining segments, including ovipositor, black.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 4,500 feet, August 10, 1929 (*Franck*).

The nearest ally is undoubtedly *Tipula* (*Formotipula*) *obliterata* Alexander (Szechwan-Tibet border), which is approximately similar in color, except that the fifth abdominal segment is extensively blackened. The latter species further has cell 1st M_2 unusually small, less than the petiole of cell M_1.

TIPULA (FORMOTIPULA) FRIEDRICHI sp. nov. Plate 1, fig. 7; Plate 2, fig. 32.

Head and thorax, with appendages, entirely velvety black; abdomen with first segment and outer five segments velvety black, the intermediate segments chiefly orange, the color somewhat variable, in cases with the orange color much reduced by encroachment of the black; wings strongly dimidiate, the cells before the cord strongly suffused with brown, the outer cells paling to gray; R_{1+2} entire; male hypopygium with the median region of the tergite produced into a lobe that terminates in an acute decurved point.

Male.—Length, 13 to 15 millimeters; wing, 12.5 to 14.5.

Female.—Length, 12 to 14.5 millimeters; wing, 13.5 to 16.5.

Head and appendages black. Antennæ of moderate length, in male if bent backward extending approximately to wing root.

Thorax, including the dorsopleural membrane, velvety black. Halteres and legs entirely black. Wings (Plate 1, fig. 7) conspicuously bicolorous, the cells before the cord strongly suffused with brown, beyond the cord paling to light gray; stigma somewhat darker brown; veins dark brown to black. Venation: R_{1+2} entire; R_2 long, perpendicular.

Abdomen somewhat variable in color, in the types with the basal segment and all of segments five to nine, inclusive, involving the genitalia of both sexes, black; segments two to four, inclusive, deep orange, the extreme posterolateral angles of both tergites and sternites black; in female, posterior median portion of first tergite orange. Other specimens that are undoubtedly conspecific have the orange of the tergites much reduced, in cases restricted to the second tergite; in still other cases the caudal borders of the normally orange tergites and sternites are broadly margined with black, greatly restricting the ground color.

Male hypopygium (Plate 2, fig. 32) with the tergite, *9t*, and sternite, *9s*, fused. Ninth tergite, *9t*, with the median region

of the outer portion narrowed and heavily blackened, the tip decurved to an acute point. Basistyle, *b*, produced caudad into a powerful blackened lobe, the tip obtuse, set with abundant short black spines and numerous long black setæ (in figure shown detached, so as not to hide other parts). Dististyle, *d*, somewhat polished black, at tip produced into two more or less opposed lobules that inclose a small rounded notch, the surface of style with abundant setæ. Ninth sternite, *9s*, on either side of median area with a smaller black lobe that is clothed with long black setæ.

Habitat.—China (Szechwan).

Holotype, male, Ginfŭ-Shan, District Nanchŭan, May 1929–31 (*Friedrich*); in Deutsches Entomologisches Museum. Allotopotype, female, in my collection. Paratypes, 10 males and females, mostly in poor condition, Mupin, altitude about 3,500 feet, 1929 (*Graham*).

This very distinct fly is named in honor of the collector of the type specimen. The nearest ally seems to be the subgenotype, *holoserica* (Matsumura), from which the present insect differs notably in the strongly bicolorous, somewhat dimidiate wings.

7. Subgenus TIPULA Linnæus

Tipula LINNÆUS, Systema Naturæ ed. 10 (1758) 585.
Tipula LACKSCHEWITZ, Konowia 9 (1930) 257–278, 2 pls.
Tipula (*Tipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 75.

Type.—*Tipula oleracea* Linnæus. (Western Palæarctic.)

Antennæ relatively short; verticils long and conspicuous, exceeding the segments in length. Frontal prolongation of head relatively long; nasus elongate.

Mesopleura glabrous, including sternopleurite (or this in cases with setæ, according to Edwards). Tibial spur formula 1–2–2; claws (male) with basal tooth. Squama naked or (more rarely with setæ; veins beyond cord with trichia. Venation: R_{1+2} entire; Rs of moderate length, from one and one-half to nearly two times the length of m-cu, the latter at or close to midlength of cell 1st M_2, somewhat closer to base in the *ultima* group.

Male hypopygium with tergite and sternite fused into a continuous ring, the suture sometimes feebly indicated posteriorly; median region of tergite produced caudad into a broadly depressed lobe (*oleracea* group) or notched medially (*luteipennis* or *ultima* group); basistyle incomplete, represented by the ven-

tral suture. Inner dististyle (*oleracea* and allies) complex, with four distinct processes, the first, or more posterior, a slender curved spine. Ovipositor with long slender cerci, the narrow tips obtuse; hypovalvæ shorter, compressed.

Species of the subgenus Tipula.

1. PALÆARCTIC EASTERN ASIA

mediolobata Alexander.
moiwana (Matsumura).
subcunctans Alexander (*czizeki* de Jong).

8. **Subgenus YAMATOTIPULA Matsumura**

Yamatotipula MATSUMURA, Thousand Ins. Japan, Add. 2 (1916) 461–462.

Tipula lateralis Formen-kreis, LACKSCHEWITZ, Naturforscher-Ver. Riga (new series) 15 (1923) 3–16, 33 figs.

Tipula (*Yamatotipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 77–78.

Type.—*Tipula nova* Walker (as *Yamatotipula nohiræ* Matsumura). (Eastern Palæarctic.)

Antennæ short (in local species) to very long; flagellar segments only feebly incised; verticils relatively small, shorter than the segments. Frontal prolongation of head moderate in length; nasus elongate.

Mesopleura glabrous. Tibial spur formula 1–1–2 or 1–2–2; claws (male) toothed. Squama naked; outer branches of M with trichia. Venation: R_{1+2} entire; Rs long, nearly if not quite twice m-cu, in extreme cases even longer; M_{3+4} short to very short, m-cu lying close to base of cell 1st M_2; second section of M_{1+2} and basal section of M_3 often parallel to one another, but the latter usually shortened by the length and obliquity of m.

Male hypopygium strongly compressed; tergite and sternite fused into a continuous ring; median region of tergite produced caudad into a simple or bifid depressed lobe, the apical margin of which is set with blackened spicules. Gonapophyses usually appearing as pale spatulate blades; a single or double tuft of yellow setæ jutting from notch of ninth sternite. Eighth sternite unarmed. Ovipositor with elongate, somewhat compressed cerci; hypovalvæ long, compressed.

Yamatotipula includes most members of the "Vittatæ," the so-called *lateralis* or *tricolor* groups of the genus. Some included species have the wings clear or nearly so, but most have the pattern distinctly striped longitudinally with brown and white (compare also some *Acutipula*). A few species have m-cu

slightly more distad in position. The subgenus is closest to the typical group *Tipula*.

Species of the subgenus Yamatotipula.

1. PALÆARCTIC EASTERN ASIA

aino Alexander.
fumida Alexander.
latemarginata Alexander.
morigera Alexander.
nova Walker (*fumifasciata* Brunetti, *nohirai* Matsumura).
parvincisa Alexander.
patagiata Alexander.
poliocephala Alexander.
protrusa Alexander.
stackelbergi Alexander.
subsulphurea Alexander.
trifida Alexander.
usuriensis Alexander.
yamamuriana Alexander.

2. PALÆARCTIC CENTRAL ASIA

mongolica Alexander.
nova Walker (see 1).
poliocephala Alexander (see 1).

9. **Subgenus ACUTIPULA Alexander**

Tipula (*Acutipula*) ALEXANDER, Arkiv för Zoologi 16 No. 18 (1924) 11–12.

Tipula (*Acutipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 79.

Type.—*Tipula gaboonensis* Alexander. (Ethiopian.)

Antennæ short in both sexes, the flagellum with very long verticils that exceed the segments in length. Frontal prolongation of head long, with elongate simple nasus.

A group of setæ on propleura. Anepisternum and sternopleurite glabrous. Tibial spur formula 1–2–2; claws (male) with basal tooth. Squama in most or all of the local species (and likewise in the subgenotype) with setæ, these usually few in number, often only three to five, but distinctly present; veins beyond cord unusually glabrous, with trichia lacking or very sparse on outer branches of M and Cu. Venation: R_{1+2} entire; in the subgenotype and most other known species in the Ethiopian fauna;[4] veins R_{1+2} and R_3 tend to lie far cephalad, greatly reducing cell R_2, which is strongly pointed at proximal end; Rs short to very short, subequal to m-cu or less; R_{4+5} ending at or beyond wing tip; medial cells full, the veins usually arcuate; m-cu at or before fork of M_{3+4}. Wings of local species usually with a darkened cloud at near midlength of cell Cu, lacking only in a few species (*alboplagiata, bipenicillata, biramosa, dicladura, munda, obtusiloba, oncerodes, platycantha, saitamæ,* and *tokionis*).

[4] Alexander, Arkiv för Zoologi 16 No. 18 (1924) 11–12.

Male hypopygium with tergite and sternite fused into a ring; basistyle complete or represented by the ventral suture only; ninth tergite conspicuously produced into a depressed or cylindrical lobe that is either bilobed or simple at apex, this set with microscopic spicules. Outer dististyle broadly flattened, of various shapes; discal setæ very sparse, marginal setæ more abundant, especially near base. Inner dististyle (in local species) with a very characteristic basic plan, but varying infinitely in the details in different species; it consists of a blackened beak on basal portion, with a second outer lobe (Plate 2, fig. 34; Plate 3, fig. 35) that is usually tipped or crowned with setæ; in some species (including *quadrinotata,* the commonest and most wide-spread form in eastern Asia) with an additional sclerotized rod between these two lobes. Caudal margin and surface of eighth sternite variously shaped, in cases with a median lobe, in others with a median crest of setæ back from margin, in still other species with lateral rows of setæ. Ovipositor with slender, straight cerci, the margins smooth; hypovalvæ subequal in length, compressed.

Species of the subgenus Acutipula.

1. PALÆARCTIC EASTERN ASIA

acanthophora Alexander.
alboplagiata Alexander.
bipenicillata Alexander.
bubo Alexander.
cockerelliana Alexander.
kuzuensis Alexander.
obtusiloba Alexander.
quadrinotata Brunetti (*fumicosta* Brunetti, *shirakii* Edwards, *pseudofulvipennis* de Meijere).
saitamæ Alexander.
tokionis Alexander.
turbida Alexander.
vana Alexander.

2. PALÆARCTIC CENTRAL ASIA

atuntzuensis Edwards.
biramosa Alexander.
bistyligera sp. nov.
brunnirostris Edwards.
captiosa Alexander.
cockerelliana Alexander (see 1).
desidiosa Alexander.
dicladura Alexander.
graphiptera Alexander.
incorrupta Alexander.
intacta Alexander.
interrupta Brunetti.
latifasciata Alexander.
megaleuca Alexander.
melampodia sp. nov.
munda Brunetti (*vicaria* Walker, preoccupied).
omeiensis Alexander.
oncerodes Alexander.
pertinax Alexander.
platycantha Alexander.
princeps Brunetti (*fuscinervis* Brunetti).
quadrinotata Brunetti (see 1).
robusta Brunetti (*fumifascipennis* Brunetti, *nigrotibialis* Brunetti).
subturbida Alexander.
yunnanica Edwards.

3. ORIENTAL EASTERN ASIA

de meijerei Edwards.
jacobsoni Edwards.
quadrinotata Brunetti (see 1).
umbrinoides Alexander.

TIPULA (ACUTIPULA) MELAMPODIA sp. nov. Plate 1, fig. 8; Plate 2, figs. 33, 34.

Allied to *graphiptera;* mesonotal præscutum dark gray, with four brown stripes, the anterior ends of the intermediate pair blending with the ground color; legs black, only the femoral bases narrowly yellow; pleura gray; wing pattern almost exactly as in *graphiptera;* basal abdominal segments obscure yellow, the outer segments black; male hypopygium with the median lobe of tergite simple but relatively broad; crest of subterminal lobe or beak high; eighth sternite with a median crest of yellow setæ.

Male.—Length, 16 to 17 millimeters; wing, 21 to 22; antenna, 5.5.

Frontal prolongation of head brownish black, the sides still darker; nasus elongate, black; palpi black. Antennæ with scape and pedicel brownish yellow; flagellum black, the base of the first segment narrowly pale. Head dark gray.

Mesonotal præscutum dark gray, with four brown stripes, the anterior ends of the intermediate pair blending with the ground color; posterior sclerites of mesonotum gray, the scutal lobes variegated by brown. Pleura chiefly light gray; dorsopleural membrane dusky. Halteres brownish black, the apices of knobs slightly paler. Legs with the coxæ gray; trochanters obscure yellow; femora black, only the extreme bases yellow, even narrower on the posterior legs; tibiæ and tarsi black. Wings (Plate 1, fig. 8) with pattern almost exactly as in *graphiptera;* brown, patterned with white, including a band across the bases of the outer medial cells, reaching the wing margin in outer half of cell R_5; white area in cell M not or scarcely confluent with the pale area before stigma, being more or less broadly interrupted near outer end of vein M.

Abdomen with basal tergite darkened; second, and parts of third and fourth segments, chiefly obscure yellow, the succeeding segments passing into black; extreme caudal borders of the segments pale. Male hypopygium with median lobe of tergite (Plate 2, fig. 33, 9*t*) simple but relatively broad at tip, the apex truncated or very indistinctly emarginate, set with black spicules. Outer dististyle and inner dististyle shaped as in figures (Plate 2, fig. 34, *od, id*); setæ at crown of outer lobe of inner style about thirty in number; subterminal lobe or beak with the crest

unusually high. Eighth sternite with the median region of caudal margin not produced but with rather abundant setæ, which tend to form a median crest back from the margin.

Habitat.—China (Szechwan).

Holotype, male, Beh-Luh-Din, 30 miles north of Chengtu, altitude 6,000 feet, July 27, 1933 (*Graham*). Paratypes, 1 male, 1 broken specimen, O–Er, 26 miles north of Li–Fan, altitude 10,800 feet, August 16, 1933 (*Graham*).

The general appearance of the present fly is very much like that of *Tipula* (*Acutipula*) *graphiptera* Alexander, likewise from western China, but differing very conspicuously in the uniformly black legs. The male sex of *graphiptera* has not been described and it cannot be stated which of the hypopygial characters are distinctive.

TIPULA (ACUTIPULA) BISTYLIGERA sp. nov. Plate 1, fig. 9; Plate 3, fig. 35.

Mesonotum gray, the præscutum with two intermediate brown stripes, the lateral stripes obsolete; pleura gray; antennæ black, the pedicel yellowish brown; legs black, the femoral bases very narrowly yellow; wings with a very strong yellowish brown tinge, sparsely variegated by cream-colored and whitish areas, the latter including a moderately wide obliterative area at cord; abdomen with basal tergites slightly variegated by yellow, trivittate with blackish, the outer segments more uniformly blackened; male hypopygium with median lobe of tergite moderately broad but entire; inner dististyle with outer lobe terminating in two long slender spines; eighth sternite without specially modified lobes or hair brushes.

Male.—Length, about 16 millimeters; wing, 17.6.

Frontal prolongation of head blackish, gray pruinose; nasus distinct; palpi black. Antennæ with scape black, sparsely pruinose; pedicel yellowish brown; flagellum black, the longest verticils a little exceeding the segments. Head gray.

Mesonotal præscutum gray, with two intermediate brown stripes that become obsolete on their anterior third, separated from one another by a relatively wide vitta of the ground; lateral stripes obsolete; scutum uniformly gray, the lobes not variegated by darker; scutellum and mediotergite gray. Pleura gray, the dorsopleural region more brownish. Halteres brown. Legs with the coxæ gray; trochanters brownish yellow; femora black, only the very narrow bases yellow, the amount subequal on all legs; tibiæ and tarsi black. Wings (Plate 1, fig. 9) with a

very strong yellowish brown tinge, sparsely variegated by whitish and cream-colored areas; the latter include spots near base of cell 1st A, before and beyond a somewhat darker brown cloud in cell Cu, and an additional spot just beyond this level in cell M; the white areas include a moderately wide obliterative area at the cord, extending into the bases of cells M_3 and M_4; base of cell M_1 whitened; slight pale streaks in cells 2d M_2 and R_5; veins dark brown, pale in the obliterative areas.

Abdomen with basal tergite light gray dorsally, broadly brownish black on sides; tergites two and three yellow sublaterally, darkened medially and on lateral portions; succeeding segments becoming more uniformly dark grayish black, margined sublaterally by velvet black, the lateral borders pale, sparsely pruinose; basal sternites yellow, beyond the second passing through dark brown to black. Male hypopygium with the median lobe of the ninth tergite (Plate 3, fig. 35, *9t*) relatively broad but entire, truncate across apex. Outer dististyle of moderate size, the apex obtusely rounded. Inner dististyle (Plate 3, fig. 35, *id*) with the outer lobe extended into two long straight spines that are not decussate but lie more or less parallel, the outer spine a little shorter and stouter than the inner, the latter with about four long setæ on margin near base; beak of style unusually high. Eighth sternite with the caudal margin evenly convex, not produced medially, the apex with abundant setæ that continue cephalad as a median group but nowhere form tufts or rows.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, Mupin, altitude about 13,400 feet, June, 1929 (*Graham*).

The type of male hypopygium of the present fly, more especially the inner dististyle, is approached only by *Tipula* (*Acutipula*) *captiosa* Alexander and *T.* (*A.*) *pertinax* Alexander, both of Kansu, western China, which are in all regards entirely different species.

10. Subgenus INDOTIPULA Edwards

Tipula (*Indotipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 81.

Tipula (*Indotipula*) ALEXANDER, Philip. Journ. Sci. 49 (1932) 231–232.

Type.—*Tipula walkeri* Brunetti. (Oriental.)

Antennæ 12-segmented, the terminal segment reduced to a mere button; flagellum moderately elongate, the longest verticils

subequal in length to or exceeding the segments; flagellar segments simple or more rarely binodose. Frontal prolongation of head short; nasus long and conspicuous. Vertical tubercle very low or lacking.

Mesopleura glabrous. Præscutum having interspaces with very sparse setæ or even quite glabrous. Tibial spur formula 0–0–2 or 0–1–2; spurs of posterior tibiæ unequal; claws (male) toothed. Squama naked; outer medial veins with trichia lacking or greatly reduced in number. Venation: R_{1+2} entire; Rs of moderate length, subequal to m-cu, in cases a little longer or shorter but not disproportionately so; cell M_1 petioled or sessile; m-cu before the level of r-m, at or close to fork of M_{3+4}, the position slightly variable even within the limits of a single species; cell 2d A narrow to very narrow.

Male hypopygium with the tergite separated from the sternite, at least in large part. Posterior margin of tergite produced into a usually bifid lobe that is set with blackened spicules. Basistyle separated from sternite by an incomplete ventral suture. Outer dististyle moderately compressed, with abundant setæ, longer on the margin. Inner dististyle variously modified, in normal forms relatively simple, the outer margin usually with a series of from six to twenty modified setæ that are flattened at their bases. Eighth sternite unarmed. Ovipositor with both cerci and hypovalvæ long and slender, smooth-margined.

Indotipula includes a monotonous aggregation of pale-colored species, with plain wings. It is the dominant group in parts of the Oriental Region and extends its range farther to the southeast than any other subgenus of the genus (*diclava* and *leptoneura* in northern Australia).

Species of the subgenus Indotipula.

1. PALÆARCTIC EASTERN ASIA

suensoni Alexander.
yamata Alexander.

2. PALÆARCTIC CENTRAL ASIA

cinctoterminalis Brunetti (somewhat doubtful, may be an *Acutipula*).
divisa Brunetti.
gracilis Brunetti.
simlensis **Edwards.**
subyamata Alexander.
tukvarensis Edwards.
walkeri Brunetti (*fulvipennis* Wlk. preoccupied; *tenuipes* Brunetti).

3. ORIENTAL EASTERN ASIA

acentrota Edwards.
angustilobata Alexander.
brevivittata Edwards.
demarcata Brunetti.
diclava Alexander.
elegantula Brunetti.
fuscoangustata Alexander.
gedehicola Alexander.
ifugao Alexander.
kinabaluensis Edwards.
korinchiensis Edwards.
latilobata Alexander.
leptoneura Alexander.
leucopyga van der Wulp (*sulaica* Walker, nondescript).
malaica Edwards.
manobo Alexander.
nudicaudata Edwards.
okinawensis Alexander.
palnica Edwards.
riverai Alexander.
sinabangensis de Meijere.
ubensis Alexander.
vilis Walker.

11. Subgenus PAPUATIPULA Alexander

Tipula (*Papuatipula*) ALEXANDER, Proc. Linn. Soc. New South Wales 59 (1934) in press.

Type.—*Tipula novæ-britannicæ* Alexander. (Australasian.)

Antennæ 13-segmented; flagellar segments with verticils that greatly exceed the segments in length. Frontal prolongation of head elongate, subequal to remainder of head; nasus distinct.

Tibial spur formula 1–2–2; spurs long and conspicuous. Squama naked; trichia of veins beyond cord unusually sparse and scattered there being a loose series on R_{4+5} and M_1. Venation: R_{1+2} entirely atrophied or represented only by a short basal spur; Rs unusually short but not transverse, approximately two-thirds m-cu; R_{2+3} very long and straight, exceeding twice m-cu; vein R_3 elongate, lying unusually close to costal border of wing, subequal in length to R_{2+3}; cell 1st M_2 elongate, its inner end strongly pointed; cell M_1 deep; m-cu uniting with M_{3+4} some distance before its fork, usually at near midlength.

Male hypopygium with the tergite separated from the sternite by a suture, fused only at extreme cephalic portion; basistyle fused with sternite. Tergite notched medially. Outer dististyle armed with a spinous point. Eighth sternite unarmed.

This subgenus has proved to be the most characteristic one in New Guinea and its satellite islands and will probably be found to be very rich in number of species when the region becomes better known. It is most nearly allied to *Acutipula* Alexander, *Tipulodina* Enderlein, and *Indotipula* Edwards, especially the first of these. It is distinguished by the venation, naked squama, and fundamentals of the male hypopygium, as the unfused tergite and sternite, notched tergite, and armed outer dististyle.

Species of the subgenus Papuatipula.

3. ORIENTAL EASTERN ASIA

divergens de Meijere.
leucosticta Alexander.
meijereana Alexander (*dentata* de Meijere, preoccupied).
novæ-britannicæ Alexander.
omissinervis (de Meijere).

12. Subgenus TIPULODINA Enderlein

Tipulodina ENDERLEIN, Zool. Jahrb., Syst. **32** (1912) 30–31.
Tipulodina BRUNETTI, Rec. Indian Mus. **15** (1918) 270–273.
Tipula (*Tipulodina*) EDWARDS, Ann. & Mag. Nat. Hist. X **8** (1931) 76.
Tipula (*Tipula*) ALEXANDER, Philip. Journ. Sci. **49** (1932) 232.

Type.—*Tipulodina magnicornis* Enderlein. (Oriental.)

Antennæ relatively short to long; flagellar segments not greatly incised; verticils long and conspicuous, exceeding the segments in length except in those species where the antennæ are very long. Frontal prolongation of head relatively short; nasus long and conspicuous. Usually with a small papillalike vertical tubercle.

Mesopleura glabrous; præscutal interspaces with very sparse setæ. Legs very long but not unusually slender; tibial spur formula 1–2–2; claws simple. Squama naked; outer medial veins with trichia quite lacking; outer radial veins often with a sparse series. Venation: R_{1+2} entire; Rs short to very short, less than m-cu, which is subequal to or longer than the distal section of Cu_1, cell M_4 thus being very short and broad; R_{4+5} long, decurved, ending beyond the wing tip; m-cu variable in position, from close to the fork of M_{3+4} to near midlength of this vein; cells M_1 and 1st M_2 full; cell 2d A narrow to very narrow.

Male hypopygium with the tergite separated from the sternite; basistyle fused with the sternite; ventrad of the dististyles, the basistyle is produced into a sclerotized rod or hook, joined at the base by a suture and not a direct prolongation of the basistyle. Outer dististyle small, broadly flattened. Ninth tergite with caudal margin more or less transverse, with a group of spinous setæ on either side of the median line. Eighth sternite often produced caudal into an acute median point. Ovipositor with cerci relatively stout, gently upcurved, the tips obtuse; hypovalvæ long, compressed.

The species of *Tipulodina* are all of large or medium size, with very long legs that are almost invariably ringed with snowy

white on the femora, tibiæ, or basitarsi. Such annuli are lacking or obscured in only a few species in the local fauna. The wings are usually crystal clear, iridescent, heavily patterned with dark or at least with the wing tip darkened; a few species have the wings beautifully tinted with amber yellow; still others have a darkened cloud at near midlength of cell M. The subgenus is eminently characteristic of the Oriental Region, with fewer species in the Ethiopian and others extending northward into Palæarctic Eastern Asia.

Species of the subgenus Tipulodina.

1. PALÆARCTIC EASTERN ASIA

joana Alexander.
nipponica Alexander.
taiwanica Alexander.

2. PALÆARCTIC CENTRAL ASIA

monozona Edwards.
patricia Brunetti.

3. ORIENTAL EASTERN ASIA

ætherea de Meijere.
albiprivata Edwards.
barraudi Edwards.
brunettiella Alexander.
cagayanensis Alexander.
ceylonica Edwards.
cinctipes de Meijere.
contigua Brunetti.
deprivata Alexander.
fumifinis Walker.
fuscitarsis Edwards.
gracillima Brunetti.
lumpurensis Edwards.
luzonica Alexander.
magnicornis Enderlein.
mckeani Cockerell.
micracantha Alexander.
pampangensis Alexander.
pedata Wiedemann.
sandersoni Edwards.
scimitar Alexander.
sidapurensis Edwards.
simillima Brunetti.
succinipennis Alexander.
tabuanensis Alexander.
tinctipes Edwards.
varitarsis Alexander.
venusta Walker.

13. Subgenus ARCTOTIPULA Alexander

Tipula (*Arctotipula*) ALEXANDER, Philip. Journ. Sci. **52** (1933) 410–411.

Type.—*Tipula besselsi* Osten Sacken. (Nearctic, Polar.)

Antennæ of moderate length, the flagellar segments feebly incised, with verticils that are shorter than the segments. Nasus in most cases relatively short, sometimes lacking.

Body conspicuously hairy, with setæ on all coxæ and usually on sternopleurite and meron but not on anepisternum. Tibial spur formula 1–2–2; claws simple. Squama naked; veins beyond cord without trichia or with these much reduced in size and

number, most persistent as a loose series on R_{4+5}; in some species, as *gavronskii,* the trichia are more abundant.

Abdomen often depressed. Male hypopygium of simple structure; tergite and sternite separate; eighth sternite unarmed. Terminal abdominal segments in female abruptly narrowed, the ovipositor very small; cerci moderately elongate and only weakly sclerotized, with smooth margins; hypovalvæ small and compressed.

The subgenus is distinguished from *Vestiplex* chiefly by the long, pale body vestiture, the unusually glabrous nature of the wing veins, and the structure of the ovipositor. *Tipula tundrensis* is aberrant in the subgenus and may possibly be better referred to *Vestiplex* despite the smooth-margined cerci. The species are chiefly far northern in their distribution.

Species of the subgenus Arctotipula.

1. PALÆARCTIC EASTERN ASIA

gavronskii Alexander.
hirtitergata Alexander.
popoffi Alexander.
tundrensis Alexander.

14. Subgenus VESTIPLEX Bezzi

Tipula (*Vestiplex*) BEZZI, Ann. Mus. Civ. Nat. Stor. Genova 51 (1924) 230–231.

Tipula (*Vestiplex*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 79–80.

Tipula (*Vestiplex*) ALEXANDER, Philip. Journ. Sci. 52 (1933) 396–398.

Type.—*Tipula cisalpina* Riedel. (Western Palæarctic.)

Antennæ short to elongate, in males of many species with flagellar segments very strongly incised; verticils of moderate length. Frontal prolongation of head elongate; nasus present or lacking.

Thoracic pleura usually glabrous, in cases (as *arctica*) with numerous setæ on sternopleurite. Tibial spur formula 1–2–2; claws (male) simple or with basal tooth (as *arctica*); legs usually stout, especially in females. Squama naked; branches of M with sparse to more abundant trichia. Venation: R_{1+2} entire; Rs long, fully one-half longer than m-cu or often considerably longer; m-cu at or close to fork of M_{3+4} and approximately opposite one-third to one-half the length of cell 1st M_2.

Male hypopygium in many species with the posterior half of tergite forming a shallow saucer, in some species heavily sclero-

tized and blackened, having the lateral angles produced caudad into acute spines. Still other species have the tergite completely divided longitudinally by pale membrane. The modifications of the hypopygium in this subgenus have been discussed in greater detail in another paper.[5] Ovipositor with the cerci strong and powerfully constructed, heavily sclerotized, horizontally placed and with the outer margin serrate; hypovalvæ very small or rudimentary, not or scarcely extending beyond the bases of the cerci. In several species the margins of the cerci have the teeth obtuse and evidently in process of being eliminated. Several species in the local fauna have been placed in *Vestiplex* with considerable question, many of these (all where the female sex is definitely known) have the cerci quite smooth and the hypovalvæ better developed. The following species, referred to *Vestiplex* in the past, are questionable and are better placed in *Oreomyza* until their characters are better known: *arisanensis, coxitalis, deserrata, foliacea, nestor, optanda, parvapiculata, quadrifulva, sternotuberculata,* and *terebrata.* The disposition of *tundrensis* in *Arctotipula* has been discussed under this generic name. Still further species belonging to the so-called *himalayensis* group, including *himalayensis* and *inæquidentata,* may likewise be found to fall in some other group but are retained herewith in *Vestiplex* until the female sex is better known.

Vestiplex includes a considerable part of the so-called "Marmoratæ," having marbled or marmorate wing patterns (compare also *Nippotipula, Sinotipula, Oreomyza,* and *Lunatipula*). The subgenus is widely distributed throughout the Holarctic region, more especially in the boreal portions and in the mountainous districts to the south.

Species of the subgenus Vestiplex.

1. PALÆARCTIC EASTERN ASIA

asio Alexander.
bicornuta Alexander.
biserra Edwards.
coquillettiana Alexander.
excisoides Alexander.
immunda Alexander.
jakut Alexander.
kamtchatkana Alexander.
kuwayamai Alexander.
nokonis Alexander.
pallitergata Alexander.
serricauda Alexander.
serridens Alexander.
subapterogyne Alexander.
subcentralis Alexander.
tchukchi Alexander.
teshionis Alexander.
transbaikalica Alexander.
verecunda Alexander.

[5] Alexander, Philip. Journ. Sci. 52 (1933) 396.

2. PALÆARCTIC CENTRAL ASIA

arctica Curtis (*aquilonia* Erichson).
avicularia Edwards.
bifida Alexander.
divisotergata Alexander.
edentata Alexander.
grahami Alexander.
hedini Alexander.
himalayensis Brunetti.
hummeli Alexander.
immota Alexander.
inæquidentata Alexander.
kwanhsienana Alexander.
leucoprocta Mik.
mediovittata Mik.
mitchelli Edwards.
nigroapicalis Brunetti.
pleuracantha Edwards.
quasimarmoratipennis Brunetti.
reposita Walker (*brevis* Brunetti).
scandens Edwards.
styligera Alexander.
subcarinata Alexander.
subscripta Edwards.
subtincta Brunetti.
tardigrada Edwards.
testata sp. nov.
tumulta Alexander.
virgatula Riedel.

3. ORIENTAL EASTERN ASIA

gedehana de Meijere.
papandajanica Edwards.

TIPULA (VESTIPLEX) TESTATA sp. nov. Plate 1, fig. 10; Plate 3, fig. 36.

Thorax yellow, the præscutum with three poorly indicated olive-brown stripes; antennæ (male) elongate, approximately one-half the length of body; flagellum black; legs black, the femoral bases narrowly yellow; wings tinged with brown, vaguely patterned with whitish areas, including an incomplete band beyond stigma; cell Sc uniformly black; R_{1+2} entire; basal abdominal tergites yellow, the outer segments black; male hypopygium with the basistyle terminating in an acute spine.

Male.—Length, 11 to 12 millimeters; wing, 12 to 13.5; antenna, 6.

Frontal prolongation of head orange-yellow, including the elongate nasus; palpi brown. Antennæ (male) elongate, if bent backward extending approximately to opposite the base of the fourth abdominal segment; scape and pedicel yellow, flagellum black, the base of the first flagellar segment paler; flagellar segments with verticils much shorter than the segments. Head brownish yellow.

Mesonotal præscutum golden yellow, with three olive-brown stripes that are poorly defined against the ground, the median one insensibly divided by paler color on posterior half; scutal lobes yellow, each with two olive-brown areas; scutellum brownish yellow; mediotergite more golden yellow, the two latter

sclerites with vague indications of a capillary dark vitta. Pleura uniformly yellow. Halteres with stem yellow, the knobs black. Legs with coxæ and trochanters yellow; remainder of legs black, the femoral bases rather narrowly yellow. Wings (Plate 1, fig. 10) with a weak brown tinge, very vaguely marked with more-whitish areas; prearcular field yellow; cell C brownish yellow, somewhat darker on outer end; cell Sc uniformly blackened throughout its length; stigma and a confluent cloud on anterior cord darker brown; a small dark cloud at origin of Rs; the whitish markings include an incomplete poststigmal fascia that passes through cell 1st M_2 into the base of cell M_3; extensive whitish areas before and beyond origin of Rs; bases of cells R, M, Cu, and the anals pale, cell Cu_1 restrictedly darkened, yellow at extreme base; veins dark brown. Venation: R_{1+2} with a series of trichia virtually to tip; petiole of cell M_1 a trifle longer than m.

Basal abdominal tergites yellow, beyond the second tergite more brownish yellow; fifth and succeeding segments, including the entire hypopygium, intense black; sternites colored like the tergites but lateral borders of outer blackened segments more conspicuously pale. Male hypopygium (Plate 3, fig. 36) with the sternite and tergite, *9t*, fused on cephalic half, separated by a suture on posterior half; basistyle, *b*, entirely cut off from the sternite, at apex produced into a gently curved black spine, the tip acute. Ninth tergite, *9t*, narrowly divided at midline by pale membrane; lateral lobes moderately elongate, black, with conspicuous black setæ; ventrad of lateral lobes with the usual glabrous blackened protuberances. Outer dististyle dusky, flattened, with abundant black setæ. Inner dististyle, *id*, with a blackened knob at base. Eighth sternite, *8s*, unarmed.

Habitat.—China (Szechwan).

Holotype, male, Beh-Luh-Din, 30 miles north of Chengtu, altitude 6,000 feet, August 8 to 10, 1933 (*Graham*). Paratopotypes, 3 males, August 12 to 17, 1933.

Tipula (*Vestiplex*) *testata* is readily told from all other small regional species of the subgenus that have the basistyle of the male hypopygium armed with a spine, by the yellow coloration of the thorax and very elongate antennæ of the male.

15. Subgenus OREOMYZA Pokorny

Oreomyza POKORNY, Wien. Ent. Zeit. 6 (1887) 50.

Tipula (*Oreomyza*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 75–76.

Type.—*Oreomyza glacialis* Pokorny. (Western Palæarctic.)

Antennæ short to moderately elongate, 13- to 15-segmented; flagellar segments weakly to strongly incised; verticils of moderate length. Frontal prolongation of head relatively elongate; nasus of moderate length or lacking (*carinifrons* group).

Mesopleura glabrous. Tibial spur formula normally 1–2–2; claws (male) simple, or more usually (as in *marmorata, trivittata,* and *unca* groups) with basal tooth. Squama naked; outer branches of M with trichia. Venation: R_{1+2} entire or, in numerous species (*mutila* group), entirely or partly atrophied; Rs of moderate length, exceeding m-cu, the latter some distance beyond fork of M, except in the *marmorata* and a few other groups.

Male hypopygium with tergite and sternite distinct; basistyle complete, at least in the majority of species; in certain forms, the basistyle produced caudad into an obtuse or acute lobe. Outer dististyle usually depressed, often dilated on outer portion into a more or less triangular head; in cases, dististyle small and nearly cylindrical. Eighth sternite simple or provided with hair brushes. Ovipositor with slender, smooth-margined, sclerotized cerci; hypovalvæ compressed, shorter than the cerci.

Oreomyza is very rich in species throughout the entire Holarctic region, being especially well developed in the local fauna. It includes the majority of the so-called "Marmoratæ," species with the wings variously clouded and spotted with brown, gray, and pale colors. Many forms in the local fauna have the wings unmarked or nearly so. The essential point of difference from *Lunatipula* lies in the glabrous squamæ, a character that in some groups, at least, may not prove to be of fundamental importance and which may tend to separate species that are in reality nearly allied. I am modifying the limits of the group to include species with simple and with toothed claws in the male sex.

As above constituted, *Oreomyza* includes several diverse elements, some of which later may be removed to other groups. The chief points of contact are with *Vestiplex* and *Lunatipula,* as discussed before. The host of species in our fauna are divisable into several natural groups, of which the following may be outlined provisionally at this time:

1. *arisanensis* group, including *arisanensis* and *foliacea.*
2. *coxitalis* group, including *coxitalis* and *sternotuberculata.*

3. *carinifrons* group, including *carinifrons, crawfordi, gynaptera,* and *malaisei.*
4. *flavolineata* group, including *curvicauda, dichroistigma, fortistyla, isshikii, nigrosignata,* and probably *westwoodiana.*
5. *juncea* group, including *longicauda* and *mystica.*
6. *marmorata* group, including *coreana, cupida, docilis, fidelis,* and *kiushiuensis.*
7. *mutila* group, including many species, possibly artificially distributed, as *edwardsella, flavocostalis, futilis, hibii, hylæa, latiflava, mutiloides, obnata, percara, quadrifasciata, striatipennis, subfutilis, submutila, sunda,* and others.
8. *seticellula* group, including *seticellula.*
9. *trivittata* group (claws of male toothed), as *apicispina* and many others.
10. *variipennis* group (claws of male simple), as *mesacantha* and many others.
11. *unca* or *borealis* group, including *amurensis.*

Species of the subgenus Oreomyza.

1. PALÆARCTIC EASTERN ASIA

amurensis Alexander.
apicispina Alexander.
arisanensis Edwards.
autumna Alexander.
chernavini Alexander.
coreana Alexander.
coxitalis Alexander.
crawfordi Alexander.
cupida Alexander.
curvicauda Alexander.
depressa Alexander.
derbecki Alexander.
dershavini Alexander.
dichroistigma Alexander.
docilis Alexander.
edwardsella Alexander (*flavicosta* Edwards, preoccupied).
famula sp. nov.
fidelis Alexander.
flavocostalis Alexander.
foliacea Alexander.
fortistyla Alexander.
futilis Alexander.
gynaptera Alexander.
hibii Alexander.
hylæa Alexander.
illegitima Alexander.
isshikii Alexander.
kiushiuensis Alexander.
lætibasis Alexander.
longicauda Matsumura.
lundströmiana Alexander.
machidai Alexander.
malaisei Alexander.
matsumuriana Alexander.
mendax Alexander.
mesacantha Alexander.
mitiphora Alexander.
mystica Alexander.
nestor Alexander.
nigrosignata Alexander.
nippoalpina Alexander.
obnata Alexander.
otiosa Alexander.
parvapiculata Alexander.
phæopasta Alexander.
pluriguttata Alexander.
politostriata Alexander.
pollex Alexander.
quadrifasciata Matsumura (*aluco* Alexander).
quadrifulva Edwards (probably here).
quadrispicata Alexander.
sachalinensis Alexander.
sempiterna Alexander.
seticellula Alexander.
s. longiligula Alexander.

Species of the subgenus Oreomyza—Continued.

1. PALÆARCTIC EASTERN ASIA—continued.

shomio Alexander.
sibiriensis Alexander.
sternotuberculata Alexander.
strix Alexander.
subfutilis Alexander.
subyusou Alexander.
superciliosa Alexander.
taikun Alexander.
tantula Alexander.
terebrata Edwards.
tetracantha Alexander.
tridentata Alexander.
trupheoneura Alexander.
uenoi Alexander.
westwoodiana Alexander.
yusou Alexander.
yusouoides Alexander.

2. PALÆARCTIC CENTRAL ASIA

amytis Alexander.
bipendula Alexander.
carinifrons Holmgren.
ciliata Lundström.
crassicornis Zetterstedt.
cruciata Edwards.
deserrata Alexander.
dolosa Alexander.
finitima Alexander
glaucocinerea Lundström.
haplorhabda sp. nov.
hirsutipes Lackschewitz.
jedoensis Alexander.
latiflava Alexander.
latistriga Edwards.
legalis Alexander.
leucosema Edwards.
leucosticta Edwards.
limbinervis Edwards.
lionota Holmgren.
macarta Alexander.
multistrigata Alexander.
mupinensis Alexander.
mutiloides Alexander.
optanda Alexander.
pedicellaris Alexander.
percara Alexander.
resupina Alexander.
rudis sp. nov.
stagnicola Holmgren.
striatipennis Brunetti.
submutila Alexander.
tetragramma Edwards.
tetramelania sp. nov.
tristriata Lundström.
vitiosa Alexander.
vivax Alexander.

3. ORIENTAL EASTERN ASIA

sunda Alexander.

TIPULA (OREOMYZA) FAMULA sp. nov. Plate 1, fig. 11; Plate 3, fig. 37.

General coloration gray, the præscutum with three brown stripes; setigerous punctures of interspaces sparse but conspicuous; a median dark vitta on posterior sclerites of mesonotum; antennæ (male) unusually long, exceeding one-half the length of body, the flagellar segments uniformly darkened, strongly nodulose; wings brown, sparsely variegated by dark brown and pale yellow areas, the latter including an incomplete fascia beyond cord; cell C infumed; R_{1+2} complete; basal abdominal segments reddish yellow, the outer segments black; male hypopygium with the caudal margin of tergite tridentate; eighth sternite with a fringe of long yellow setæ.

Male.—Length, about 12 millimeters; wing, 13; antenna, about 6.8.

Frontal prolongation of head dark gray; nasus distinct; palpi black. Antennæ (male) unusually long, exceeding one-half the length of body, if bent backward extending about to the base of the fourth abdominal tergite; scape and pedicel obscure yellow; succeeding segments almost uniformly dark brown; flagellar segments beyond the first strongly nodulose, much as in *serta* and allies; longest verticils subequal in length to the segments; terminal segment exceeding one-half the length of the penultimate. Head brownish gray; anterior vertex with an impressed median line back from the summit of the tubercle.

Mesonotal præscutum gray, with three brown stripes, the lateral pair entire, the median stripe with the central half entire, the lateral portions paler gray, this latter color continuing caudad almost to the posterior end of stripe as a delicate line just inside the dark lateral border of the stripe; setigerous punctures of the interspaces sparse, dark brown; scutum gray, each lobe with two dark brown areas; posterior sclerites of notum gray; a slightly interrupted brown median vitta extending from the suture to the abdomen. Pleura gray; dorsopleural membrane buffy yellow. Halteres obscure yellow, the bases of knobs dusky. Legs with the coxæ gray; trochanters yellow; femora obscure yellow, the tips rather broadly but weakly dark brown; tibiæ obscure yellow, the tips more extensively dark brown; tarsi black; claws (male) with a weak subbasal tooth. Wings (Plate 1, fig. 11) with a strong brown tinge, sparsely variegated by darker brown and cream-colored areas; prearcular field and cell Sc clear yellow; cell C infumed; stigma and a confluent area on anterior cord darker brown; wing apex almost uniformly darkened, a trifle paler in the outer medial field; an incomplete pale crossband beyond stigma, narrowly reaching the costa at vein R_{1+2}, behind extending into cell M_3; cells R and M darkened medially, variegated by pale at bases and in outer ends; a broad pale seam along outer third of vein 1st A; veins brown, brighter in the pale areas. Macrotrichia of veins relatively abundant; on more than basal half of R_{1+2}; a group of about seventeen trichia on posterior border of stigma. Venation: R_{1+2} entire but pale on distal third; cell 1st M_2 slightly elongate, the second section of M_{1+2} exceeding twice the basal section.

Abdomen with first segment brownish gray; succeeding three or four segments almost uniformly reddish yellow, the outer segments blackened. Male hypopygium (Plate 3, fig. 37) with the tergite, *9t*, entirely separated from the sternite, *9s;* basistyle entirely cut off from the sternite, its caudal margin not produced. Ninth tergite, *9t*, with the caudal margin tridentate, the lateral lobes obtuse, the median lobe acute and sending a median carina back onto the dorsal surface of the tergite; dorsal surface with abundant erect setæ. Outer dististyle broadly expanded on outer half. Inner dististyle, *id*, with a glabrous lobe on outer margin, directed outward; posterior basal angle of style produced caudad into a shorter, more obtuse lobe that is provided with scattered setæ. Eighth sternite, *8s*, on and near caudal margin with a dense median brush of long yellow setæ.

Habitat.—China (Chekiang).

Holotype, male, hills south of Ning-po, halfway to Nimrod Sound, May 1, 1925 (*E. Suenson*).

The present fly is very different from other regional species of *Oreomyza* in the elongate nodulose antennæ, which are very similar to the otherwise quite different *Tipula* (*Oreomyza*) *lundströmiana* Alexander and other members of the *serta* group. Aside from the antennæ, the present fly suggests species such as *T.* (*O.*) *futilis* Alexander and *T.* (*O.*) *legalis* Alexander, yet is very different.

TIPULA (OREOMYZA) TETRAMELANIA sp. nov. Plate 1, fig. 12; Plate 3, fig. 38.

Mesonotal præscutum gray, with four polished black stripes; antennal flagellum black; knobs of halteres blackened; legs yellow, the tips of the femora and tibiæ conspicuously blackened; wings brown, sparsely variegated by whitish and darker brown, including an incomplete pale fascia beyond the stigma; R_{1+2} entire; basal abdominal segments yellow, inconspicuously lined with darker; fifth and succeeding segments black; male hypopygium with the caudal margin of tergite trilobed; eighth sternite with a simple fringe of setæ on caudal border.

Male.—Length, 10 to 11 millimeters; wing, 10.5 to 12.

Female.—Length, 14 to 15 millimeters; wing, 13.5 to 14.

Frontal prolongation of head brown, narrowly blackened above; nasus elongate; palpi brown, the incisures paler, the outer segments brownish black. Antennæ moderately elongate, in male if bent backward extending nearly to root of halteres; scape and pedicel obscure yellow; flagellum black; verticils a

little longer than the segments. Head gray; anterior vertex relatively narrow.

Pronotum gray. Mesonotal præscutum gray with four conspicuous, polished black stripes, the intermediate pair separated by a diffuse line of the ground color; scutum gray, the lobes more blackened; scutellum polished black; mediotergite black, sparsely pruinose on sides. Pleura black, heavily pruinose, the ventral sternopleurites less heavily so, to appear somewhat polished. Halteres with the stem yellow, the knobs blackened. Legs with the coxæ dark brown, sparsely pruinose; femora and tibiæ obscure yellow, the tips conspicuously blackened; tarsi black, the proximal ends of basitarsi a little paler; claws (male) with basal spine. Wings (Plate 1, fig. 12) with the ground color brown, variegated by whitish and sparse darker brown areas; prearcular region and cell Sc yellow, cell C more brownish yellow; stigma and a confluent cloud on anterior cord darker brown; a narrow and incomplete pale crossband beyond cord, including bases of cells R_2, R_3, and R_5; in cases, the outer medial field pale, in still other specimens being of the ground color; a dark cloud in prearcular field, following the radial vein; an entire dark band extending from vein R to the posterior margin at near midlength of the basal cells of wing; veins brownish black, more yellowish in the flavous portions. Trichia of veins relatively short, virtually lacking on 1st A. Venation: R_{1+2} entire, with trichia except on the pale outer third; cell 1st M_2 relatively small.

Abdomen (male) with the basal four segments chiefly light yellow, the tergites usually very vaguely and indistinctly darkened medially and on the sides, the latter more evident, in cases the markings more distinct; sternites similarly light yellow, unmarked; outer abdominal segments, including hypopygium, black. In female, the basal abdominal tergites are more distinctly trivittate with black; genital shield obscure yellow. Male hypopygium (Plate 3, fig. 38) with the basistyle relatively small, entirely cut off from sternite by sutures. Ninth tergite, *9t*, a simple transverse plate, without blackened lobes or other modifications; caudal portion narrowed, the margin with three lobes, the lateral lobes broader and more obtuse than the slender median lobes. Outer dististyle, *od*, a little flattened, sinuous, with unusually long setæ. Inner dististyle, *id*, with the caudal or posterior margin notched, with a small, pale, conical point near

base. Eighth sternite, 8s, with posterior margin provided with a simple fringe of long yellow setæ, smaller and restricted in number near the midline. Ædeagus very stout. Ovipositor with the cerci long and slender, straight.

Habitat.—China (Szechwan).

Holotype, male, Beh-Luh-Din, 30 miles north of Chengtu, altitude 6,000 feet, August 18, 1933 (*Graham*). Allotopotype, female, August 2, 1933. Paratopotypes, 7 males and females, August 16 to 27, 1933. Paratype, 1 male, Mu-Sang-Tsai, 10 miles northwest of Wei-Chow, altitude 8,000 to 10,000 feet, July 2 to 6, 1933 (*Graham*).

Despite marked differences in coloration of body and wings, I believe the present fly to be related to *Tipula* (*Oreomyza*) *cruciata* Edwards and allies. It is amply distinct in the pattern of the thorax and abdomen, and in the details of structure of the male hypopygium, especially of the tergite.

TIPULA (OREOMYZA) RUDIS sp. nov. Plate 1, fig. 13; Plate 3, figs. 39 and 40.

Most nearly allied to *finitima;* mesonotal præscutum brownish gray, with four slightly darker brown stripes; scutellum uniformly darkened; wings strongly suffused with brownish yellow, the stigma darker; obliterative areas much restricted; basal abdominal segments yellowish, the outer segments darkened; male hypopygium with the basistyle large, entire, its caudal end produced into a broad, truncated, blackened lobe; eighth sternite with a fringe of setæ.

Male.—Length, about 15 millimeters; wing, 16; antenna, about 5.

Frontal prolongation of head brownish gray; nasus distinct; palpi brownish black. Antennæ (male) moderately elongate, as shown by the measurements; scape brownish yellow; pedicel yellow; flagellar segments weakly bicolorous, the basal enlargements of the segments dark brown, the remainder somewhat paler brown; longest verticils subequal in length to the segments. Head dark gray, the anterior vertex badly damaged in the unique type.

Mesonotal præscutum brownish gray, with indications of four slightly darker, more brownish stripes; scutum with lobes uniformly dark gray; posterior sclerites of notum dark gray. Pleura uniformly dark gray; dorsopleural membrane buffy yellow. Halteres with stem brownish yellow, the knobs darkened. Legs with the coxæ gray; trochanters brownish yellow; re-

mainder of legs broken. Wings (Plate 1, fig. 13) with a brownish yellow tinge, cells C, Sc, and Cu more saturated; stigma slightly darker brown; obliterative areas before and beyond stigma and across cord greatly reduced, very inconspicuous, especially the latter; veins brown. Venation: R_{1+2} entire; Rs somewhat longer than m-cu.

Abdomen with basal segments yellow, the tergites scarcely darkened medially; on third and succeeding tergites a narrow dark sublateral stripe begins, broadening behind; outer abdominal segments darkened. Male hypopygium (Plate 3, fig. 39) with the basistyle, *b*, very large, entirely cut off from the sternite, its caudal end broadly produced into a short, obtusely truncated, blackened lobe. Ninth tergite (Plate 3, fig. 40, *9t*) long, narrowed on posterior third, with heavily blackened lateral lobe on either side and a low, paler, median lobe; dorsomedian portion of tergite narrowly but distinctly divided by pale membrane. Outer dististyle small, weakly clavate, with long setæ. Inner dististyle, *id*, with a setiferous lobe at base of posterior portion, connected with the head portion by extensive, almost clear membrane. Ninth sternite profoundly incised; on its margin, ventrad and cephalad of the basistyle, a tumid blackened lobe whose posterior portion bears abundant setæ. Eighth sternite, *8s*, with median region of caudal margin very gently concave and provided with a fringe of long setæ.

Habitat.—China (Szechwan).

Holotype, male, O-Er, 26 miles north of Li-Fan, altitude 9,000 feet, August 6 to 16, 1933 (*Graham*).

The nearest described ally is the very similar *Tipula* (*Oreomyza*) *finitima* Alexander (Kansu), which differs especially in the structure of the male hypopygium, notably the basistyle and inner dististyle.

TIPULA (OREOMYZA) HAPLORHABDA sp. nov. Plate 1, fig. 14.

General coloration of thorax brownish gray, the præscutum with four dark brown stripes; femora black, with a broad yellow subterminal ring on all legs; wings whitish, variegated by grayish brown and darker brown areas, the pattern not so definitely quadrifasciate as in most members of the subgroup; white crossband beyond cord unusually broad; cell 2d A almost undarkened; vein R_{1+2} represented by a spur that includes about one-half the normal length of the vein.

Female.—Length, about 22 millimeters; wing, 18.5.

Frontal prolongation of head black, sparsely pruinose; nasus unusually elongate; palpi black. Antennæ black, the pedicel and apex of scape restrictedly brightened; scape elongate, exceeding in length the combined first and second flagellar segments; verticils subequal to the segments. Head gray.

Pronotum gray, with a median dark brown vitta. Mesonotal præscutum dark brownish gray, with four dark brown stripes, the intermediate pair separated throughout their length by a capillary line of the ground color; posterior sclerites of notum pruinose, the mediotergite clearer gray, with a capillary brown line. Pleura uniformly gray; dorsopleural region yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ gray; trochanters brownish yellow; femora black, the extreme bases obscure yellow; a broad yellow subterminal ring on all femora, this subequal in width to the dark apex (forelegs) or much broader, about one-half wider than apex (hind legs); tibiæ brown to brownish black, paler at base, darker at tip; tarsi brownish black. Wings (Plate 1, fig. 14) whitish, variegated by grayish brown and dark brown areas; prearcular region and cells C and Sc uniformly pale; darker brown areas include the stigma and a major confluent area on anterior cord and on distal third of Rs; origin of Rs; bases of cells R and M; conspicuous seams along m-cu and distal section of Cu_1; darkened wing tip relatively narrow, including less than the distal half of cells R_2, R_3, or R_5; inner end of darkened apex about on a level with the fork of M_{1+2}; paler clouds in cells M, Cu, and 1st A; veins M_3 and 2d A narrowly seamed with dark brown; cell 2d A almost clear, its apical border narrowly darkened; veins brownish yellow, darker in the clouded areas. Venation: R_{1+2} preserved on about its basal half; Rs elongate, exceeding vein R_3.

Abdomen black, sparsely pruinose, the lateral borders somewhat broadly pruinose. Ovipositor with the genital shield polished black; cerci long and slender, brownish black.

Habitat.—China (Szechwan).

Holotype, female, O-Er, 26 miles north of Li-Fan, altitude 10,800 feet, August 16, 1933 (*Graham*).

The yellow subterminal rings on the femora remind one strongly of the condition found in *Tipula* (*Oreomyza*) *latiflava* Alexander (Szechwan), but the wing pattern is quite distinct, notably the clear cells C and Sc and the relatively narrow dark-

ened wing tip. The long basal spur of vein R_{1+2} is different from that found in any of the members of the *mutila* group. The fly is even closer to two Burmese species, *T.* (*O.*) *latistriga* Edwards and *T.* (*O.*) *leucosticta* Edwards, but differs in the thoracic pattern and the wing coloration, notably the unusually wide white band beyond the cord and the virtually immaculate cell 2d A.

16. Subgenus LUNATIPULA Edwards

Tipula (*Lunatipula*) EDWARDS, Ann. & Mag. Nat. Hist. X 8 (1931) 81–82.

Type.—*Tipula lunata* Linnæus. (Western Palæarctic.)

Antennæ usually short, the verticils exceeding the segments in length. Frontal prolongation of head relatively long, with short to long nasus.

Mesopleura usually glabrous, in cases (including the subgenotype) with a few setæ on sternopleurite and meron. Tibial spur formula 1–2–2; claws (male) with basal tooth. Squama with a group of setæ, these usually abundant; veins beyond cord with trichia. Venation: R_{1+2} usually entire, in some species (as *manca*) more or less atrophied; Rs variable in length, ranging from subequal to m-cu to more than twice this length; vein R_3 straight or nearly so; R_{4+5} ending before wing tip.

Male hypopygium with tergite and sternite distinct. Tergite almost invariably with a median notch. Outer dististyle small to merely depressed-clavate. Eighth sternite usually provided with hair brushes, pencils, or fleshy lobes. Ovipositor with cerci long and slender, smooth-margined; more rarely (*fascipennis* and *marmoratipennis* groups) with cerci and hypovalvæ short and fleshy.

Lunatipula includes a certain proportion of the so-called "Subunicolores," species with the wings unmarked or virtually so and with the obliterative area at the cord forming a conspicuous pale lunule against the ground color. Some of the groups include species with heavily patterned wings.

As here classified, the subgenus divides into more or less natural groups, of which the following may be indicated:

1. *lunata* group, including *polypogon* and several others.
2. *fascipennis* or *bicornis* group, including *annulicornuta*, *pseudogyne*, *tateyamæ*, *turanensis*, and *validicornis*.
3. *marmoratipennis* group, including *holoteles*, *marmoratipennis*, *multibarbata*, *multisetosa*, *naviculifer*, and *shogun*.

4. *macrolabis* group, including *macrolabis*.
5. *oreada* group, including *oreada*.

Species of the subgenus Lunatipula.

1. PALÆARCTIC EASTERN ASIA

ampliata Alexander.
annulicornuta Alexander.
flaccida Alexander (probably).
gondattii Alexander.
holoteles Alexander.
lamentaria Alexander.
macrolabis Loew.
manca Alexander.
multibarbata Alexander.
naviculifer Alexander.
pendula Alexander.
plagiotoma Alexander.
polypogon Alexander.
pseudogyne Alexander.
shogun Alexander.
sublimitata Alexander.
tateyamæ Alexander.
terebrina Alexander.
turanensis Alexander.
validicornis Alexander.

2. PALÆARCTIC CENTRAL ASIA

absconsa Alexander.
marmoratipennis Brunetti.
minensis Alexander.
multisetosa Alexander.
nigrobasalis Alexander.
oreada Alexander.
subvernalis Alexander (*fasciculata* Brunetti, preoccupied) (probably occurs in 2).
transfixa Alexander.
trialbosignata Alexander.
variipetiolaris Alexander.

Genus PRIONOCERA Loew

Prionocera LOEW, Stettin. Ent. Zeitg. 5 (1844) 170.
Stygeropis LOEW, Berlin. Ent. Zeitschr. 7 (1863) 298.

PRIONOCERA LÆTIPENNIS sp. nov. Plate 1, fig. 15; Plate 3, fig. 42.

General coloration brownish gray, the præscutum with four slightly darker stripes; antennæ with flagellar segments strongly nodulose, with short apical pedicels, the basal segments yellow; wings strongly suffused with yellow, the costal portions more saturated; abdomen yellow, with a continuous black median stripe on the tergites.

Male.—Length, about 12 to 13 millimeters; wing, 12.5 to 13.5.

Female.—Length, 15 to 16 millimeters; wing, 16 to 16.5.

Frontal prolongation of head of moderate length, obscure yellow, darker beneath; nasus long and slender; basal segments of palpi dark brown, the outer two-thirds of terminal segment paling to yellow. Antennæ with basal three segments yellow, the succeeding segment dark in middle, pale at both ends; third flagellar segment dark basally, the apex a little brightened; remainder of flagellum black; first flagellar segment long and

slender, exceeding the scape and about equal in length to the next two flagellar segments taken together (Plate 3, fig. 41); flagellar segments short and crowded, the basal enlargement strongly produced beneath; subterminal segment with a more slender apical neck that is subequal in length to the enlarged basal portion; terminal segment slender, subequal in length and only a little thicker than the pedicel of the penultimate segment; flagellar segments clothed with short abundant erect setæ and with two apical verticils at extreme apex of outer case. Head chiefly dark brown, deepest just behind the antennal fossæ; posterior orbits a little brighter; a capillary dark brown median vitta.

Mesonotal præscutum brown with four scarcely darker brown stripes, the intermediate pair separated by a capillary dark brown vitta; scutal lobes brownish gray; posterior sclerites of notum brownish yellow, sparsely pruinose. Pleura almost uniformly grayish white pruinose, the sternopleurite and ventral meron darker gray, the pteropleurite and pleurotergite clearer yellow. Halteres brownish yellow, the knobs darkened. Legs with the coxæ grayish white; trochanters yellow; femora yellow, the tips narrowly blackened; tibiæ brownish yellow, the tips narrowly darkened; tarsi yellowish brown, passing into black. Wings (Plate 1, fig. 15) strongly suffused with yellow; cell Sc clearer yellow, cell C a trifle more brownish yellow; stigma darker brown; cephalic portion of cells R and R_1 more suffused with pale brown; vague pale central streaks in cells M and 1st A; veins yellow to brownish yellow. Veins with sparse trichia, including a series on basal half of R_3 and a sparse scattered series on outer two-thirds of R_{4+5}; M, Cu, and anal veins glabrous. Venation: Rs subequal to R_3.

Abdominal tergites yellow, with a very conspicuous, continuous, black, median stripe that is narrow on the basal tergite, widening slightly behind, at widest point about equal to the pale lateral margins; sternites reddish yellow, the seventh to ninth segments more darkened. Male hypopygium with the tergite (Plate 3, fig. 42, 9*t*) transverse, the posterior border blackened, each outer lateral angle terminating in a small black tooth. Outer dististyle, *od,* flattened, on inner margin before apex with a tumid, setiferous lobe. Inner style, *id,* with apical beak elongate. Ovipositor with cerci relatively short, the tips obtuse, the basal portions relatively wide; surface fleshy, with microscopic yellow setulæ.

Habitat.—China (Szechwan).

Holotype, male, Mupin, altitude 3,500 feet, June, 1929 (*Graham*). Allotopotype, female. Paratopotypes, 3 males and females. Paratypes, 1 male, Kwanhsien, May 28, 1930 (*Graham*); 1 female, Chengtu, altitude 1,700 feet, July 13 to 15, 1933 (*Graham*).

Prionocera lætipennis is readily told from *P. indica* Edwards (India, Assam, and French Indo-China) and *P. altivolans* sp. nov. (China-Tibet border) by the conspicuously brightened wings, which are strongly suffused with yellow, instead of the usual grayish tinge. The genus has not been recorded from China.

PRIONOCERA ALTIVOLANS sp. nov. Plate 1, fig. 16.

Female.—Length, about 14 to 15 millimeters; wing, 14 to 15.

Allied to *lætipennis* sp. nov., yet obviously distinct. The chief differences are as follows: Entire head, including the frontal prolongation, dark brown, the latter a trifle paler on sides. Antennæ brownish black throughout, including both scape and pedicel. Posterior parts of head variegated with silvery gray on orbits. Mesonotal præscutum with the dorsum almost uniformly dark brown, the stripes a little darker than the interspaces; capillary dark median vitta well indicated on cephalic half of sclerite; a dusky spot in humeral region, cephalad of the lateral stripes; posterior sclerites of notum much darker than in *lætipennis;* mediotergite clear gray. Legs with the femoral tips more broadly blackened. Wings (Plate 1, fig. 16) with the prearcular and subcostal fields, together with the narrow cell Cu_1, clear yellow, the remainder of wing more gray. Trichia on veins R_3 and R_{4+5} very sparse, especially reduced on the latter vein. Venation: Rs somewhat shorter and more arcuated. Abdomen with tergites chiefly dark brown, the lateral borders narrowly more yellowish; sternites dark. Ovipositor with cerci narrower on basal portion.

Habitat.—China (Szechwan-Tibet border).

Holotype, female, near Tang-Gu, altitude 14,000 feet, August 3 to 6, 1930 (*Graham*). Paratopotype, female.

Genus NEPHROTOMA Meigen

Nephrotoma MEIGEN, Illiger's Mag. 2 (1803) 262.
Pachyrrhina MACQUART, Suit. a Buffon 1 (1834) 88.

NEPHROTOMA RETENTA sp. nov. Plate 1, fig. 17; Plate 4, fig. 43.

Antennal flagellum black; occipital band black, its anterior end obtuse; margins of pronotal scutellum blackened; præscutal

stripes polished black, very narrowly margined with velvety black; scutellum brownish yellow; mediotergite yellow, with two more reddish yellow areas at posterior border; pleura yellow, variegated with reddish; fore femora extensively blackened; wings almost uniformly suffused with pale brownish yellow, the stigma scarcely darker; Sc_2 extending distinctly beyond origin of Rs, Sc_1 preserved; Rs long; abdominal tergites trivittate with black.

Male.—Length, about 11 millimeters; wing, 12.

Female.—Length, about 14 millimeters; wing, 13.

Frontal prolongation of head light yellow, narrowly blackened dorsally; nasus long and conspicuous, black; palpi black throughout. Antennæ with scape yellow; pedicel brownish yellow; base of first flagellar segment obscure yellow, the color continued up the lower face; remainder of flagellum black; flagellar segments relatively long and slender, slightly exceeding the longest verticils, only moderately incised; terminal segment small, subequal in length to the basal enlargement of the penultimate segment. Head orange, the summit of the vertical tubercle more yellowish; occipital brand black, conspicuous, subtriangular, its anterior end broadly obtuse, not surpassing the posterior vertex.

Pronotum yellow, the margins of the scutellum and propleura narrowly lined with black. Mesonotal præscutum yellow, with three shiny black stripes that are very narrowly bordered by velvety black; lateral stripes straight, but with a weak, somewhat paler area at their anterior ends giving the appearance of being outcurved; scutum light yellow, the lobes variegated with two confluent black areas; outer end of suture, laterad of the outer dark markings, narrowly bordered by black, in the female more extensively darkened; scutellum brownish yellow; mediotergite pale yellow, the posterior border with two more reddish yellow areas. Pleura yellow, more reddish on anepisternum, ventral sternopleurite, and ventral meron; posterior border of ventral pleurotergite narrowly darkened. Halteres pale brown, the knobs weakly darkened. Legs with the coxæ orange-yellow; trochanters obscure yellow; femora yellow, the tips blackened, more extensively so on the fore pair where about the distal half is darkened, much narrower on the posterior legs; tibiæ yellowish brown, the tips broadly blackened; tarsi black. Wings (Plate 1, fig. 17) almost uniformly suffused with pale brownish yellow, the prearcular region and cells C and Sc a trifle clearer

yellow; stigma very pale, scarcely darker than the ground; veins dark brown. Venation: Sc_2 extending distinctly beyond origin of Rs, Sc_1 preserved; Rs unusually long, subequal to R_{2+3}; cell M_1 rather broadly sessile; m-cu just before fork of vein M_4.

Abdomen yellow, the tergites trivittate with black, the median stripe in female unusually broad; sternites yellow, weakly darkened medially. Male hypopygium with the tergite (Plate 4, fig. 43, 9*t*) produced into acute spinous points on either side beneath the dorsal surface. Outer dististyle, *od*, long-attenuate. Inner dististyle, *id*, simple. Eighth sternite deeply emarginate, without lobes of any kind, the setal fringe moderately long and dense.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, near Yien-Long-Shien, altitude 13,000 to 15,000 feet, August 3 to 6, 1930 (*Graham*). Allotype, female, Yin-Kuan-Tsai, altitude from 13,000 to 15,000 feet, July 25, 1930 (*Graham*).

The present fly is quite distinct from other previously described regional species in the diagnostic features listed, notably the immaculate wings with somewhat peculiar venation. It is more nearly allied to other species described at this time.

NEPHROTOMA ATTENUATA sp. nov. Plate 1, fig. 18; Plate 4, fig. 44.

Antennæ black, only the scape brightened above in certain cases; occipital brand black, sending an anterior prolongation almost to summit of vertical tubercle; præscutal stripes three, black, narrowly bordered by opaque velvety black; scutellum darkened; mediotergite yellow, with a pale brown median vitta; wings almost uniformly brownish yellow, the stigma a trifle darker; Sc_2 ending opposite origin of Rs; cell M_1 sessile; abdominal tergites trivittate with brownish black; male hypopygium with outer dististyle greatly attenuated.

Male.—Length, about 10 millimeters; wing, 11 to 11.5.

Frontal prolongation of head yellow, broadly dark brown above; palpi black throughout. Antennæ of moderate length, in male, if bent backward, extending to some distance beyond base of abdomen; in type specimen, black throughout; in paratypes, with the scape restrictedly yellow on upper face; flagellar segments very weakly incised. Head orange-yellow, the front light sulphur yellow; occipital brand very conspicuous, black, sending an anterior prolongation almost to summit of vertical

tubercle; a small black spot adjoining eyes behind each antennal fossa.

Pronotum light yellow, the scutellum very restrictedly darkened medially, more extensively so on sides. Mesonotal præscutum with three subnitidous black stripes that are narrowly bordered by opaque velvety black, the lateral stripes straight or with only a slight extension laterad of the velvety-black anterior ends; median stripe reaching the suture behind; scutum yellow, each lobe with two confluent subnitidous areas that are narrowly bordered by velvety black; scutellum weakly to strongly darkened, the parascutella darkened; mediotergite yellow, with a median pale brown line, the posterior border slightly more reddish. Pleura yellow, the anepisternum and ventral sternopleurite and meron more reddish; linear black dashes on posterior border of sternopleurite and anepisternum, ventral edge of pleurotergite, and posterior portion of lateral pretergites. Halteres dusky, the knobs more or less brightened. Legs with the coxæ and trochanters yellow; femora obscure yellow, the tips passing into black, broadest on the forelegs; tibiæ brown basally, passing into black; tarsi black. Wings (Plate 1, fig. 18) with a strong brownish yellow tinge, the stigma a trifle darker brown; veins dark brown to brownish black. Venation: Sc_2 ending opposite origin of the short Rs, Sc_1 lacking or preserved only as a basal spur; cell M_1 sessile; m-cu just before fork of M_4.

Abdominal tergites orange-yellow, narrowly trivittate with brownish black, the areas narrowly interrupted at the incisures; sternites yellow, unmarked. Male hypopygium with the outer dististyle (Plate 4, fig. 44, *od*) exceedingly produced and attenuated. Inner dististyle, *id,* with the beak slender, the outer portion elevated into a pale membranous crest that is produced caudad into a long tail-like portion. Ninth sternite just before the caudal margin of the eighth sternite with a small, pale, fingerlike lobe, directed ventrad and slightly cephalad. Eighth sternite with the caudal margin nearly transverse, not emarginate, but with the whole posterior third of the sclerite pale, with white membrane, on either side of which the setæ are longer and more aggregated.

Habitat.—China (Szechwan-Tibet border).

Holotype, male, near Yien-Long-Shien, altitude 13,000 to 15,000 feet, August 3 to 6, 1930 (*Graham*). Paratopotypes, 2 males.

The present fly is most generally similar to *Nephrotoma retenta* sp. nov., agreeing in the general coloration of the body and wings. It is very different in the details of coloration and venation, and especially in the structure of the male hypopygium.

NEPHROTOMA IMPIGRA sp. nov. Plate 1, fig. 19; Plate 4, fig. 45.

General coloration yellow; præscutum with three polished black stripes; scutellum brownish black or black; mediotergite darkened in central portion; antennæ (male) relatively long, if bent backward extending about to the base of abdomen; flagellum black; wings whitish subhyaline, cell Sc uniformly darkened; M_4 and m-cu both at or close to proximal end of cell 1st M_2; abdominal tergites yellow, with a median, brownish black stripe, narrowly interrupted at posterior borders of segments, the lateral stripes lacking; male hypopygium with lateral portions of tergite produced caudad into slender, straight, spike-like horns.

Male.—Length, 8.5 to 9 millimeters; wing, 9.5 to 10.

Female.—Length, 11 to 12 millimeters; wing, 11 to 11.5.

Frontal prolongation of head yellow, darker above, including the nasus; palpi brownish black, the outer segment somewhat paler. Antennæ in male relatively long, if bent backward extending about to base of abdomen; scape light yellow; pedicel obscure yellow; flagellum black; flagellar segments moderately incised, the verticils much shorter than the segments. Head orange-yellow; occipital brand brown, conspicuous, sending a median spurlike point to the base of vertical tubercle; orbital darkening barely indicated.

Pronotum broadly yellow medially, dark brown on sides. Mesonotal præscutum yellow, with three polished black stripes, the lateral pair usually with a faint brownish cloud opposite their outer cephalic end; scutum yellow, the lobes chiefly covered by polished black areas; scutellum brownish black to black, the parascutella yellow; mediotergite yellow, narrowly dark brown medially, the posterior border with two contiguous circular black areas. Pleura yellow, with reddish areas on anepisternum, ventral sternopleurite, ventral meron and on pleurotergite, the latter area encircling the ventral pleurotergal area. Halteres with stem brownish yellow, the base of knob darkened, the apex again brightened. Legs with the coxæ and trochanters yellow; femora chiefly dark brown, the bases restrictedly yellow; tibiæ brown, the tips passing into dark brown; tarsi brownish black. Wings

(Plate 1, fig. 19) whitish subhyaline; cell Sc uniformly darkened; stigma brown, moderately conspicuous; veins brownish black. Venation: Sc_1 present as a spur; Rs pale, subequal to basal section of R_{4+5}; cell M_1 petiolate; M_4 departing at fork of M, with m-cu at this same point, and so close to base of cell 1st M_2, in cases a little beyond the base, as in *distans*.

Abdominal tergites yellow, with a median brownish black stripe, narrowly interrupted at the posterior borders of the segments; lateral stripes quite lacking; on sixth and seventh segments the black color more extensive; sternites uniformly pale, the seventh and eighth more or less blackened; hypopygium pale. Male hypopygium with the ninth tergite (Plate 4, fig. 45, *9t*) on either side projected into slender, straight, spikelike horns, each with a series of six or seven blackened points along their mesal edge; more mesally, the caudal margin of tergite is densely set with blackened points that are directed away from the median line. Dististyles, *od, id,* as figured. Eighth sternite with caudal border transverse, unarmed, the median region at and back from the margin with long abundant yellow setæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 10, 1929 (*Franck*). Allotopotype, female, pinned with type. Paratopotypes, 8 males and females, August 10 to 15, 1929 (*Franck*). Paratype, 1 male, Beh-Luh-Din, altitude 6,000 feet, August 23 to 24, 1933 (*Graham*).

The nearest ally is the species next described as *Nepthrotoma pilata* sp. nov., which differs especially in the details of coloration and structure of the male hypopygium.

NEPHROTOMA PILATA sp. nov. Plate 1, fig. 20; Plate 4, fig. 46.

Male.—Length, about 10 millimeters; wing, 10.5.

Generally similar and closely allied to *N. impigra* sp. nov., differing as follows:

Frontal prolongation of head entirely pale yellow, including the nasus, the vestiture light golden yellow. Occipital brand greatly reduced and poorly delimited, appearing only as an irregular brown suffusion; orbital darkenings small but evident. Præscutal stripes highly polished, very narrowly margined by velvety black; lateral stripes straight; central darkening of mediotergite extensive. Wings (Plate 1, fig. 20) a trifle more suffused with dusky. Venation: Cell M_1 very short-petiolate to nearly sessile. Darkenings on abdominal tergites more exten-

sive. Male hypopygium with the lateral spines of the tergite (Plate 4, fig. 46, *9t*) broad-based, the tips obliquely truncated; groups of spines on caudal border of tergite more compact, subglobular in outline. Dististyles, *od, id,* as shown; inner style very deep. Eighth sternite nearly transverse across caudal margin, at midline of posterior edge with a small compressed lobe, directed ventrad, truncated at apex; surface of sternite behind this lobe with long, conspicuous, yellow setæ.

Habitat.—China (Szechwan).

Holotype, male, Chengtu, altitude 1,700 feet, April 11 to 14, 1933 (*Graham*).

NEPHROTOMA IMMEMORATA sp. nov. Plate 1, fig. 21; Plate 4, fig. 47.

General coloration yellow, the præscutum with three polished black stripes, the lateral pair outcurved; occipital brand scarcely evident; prothorax entirely pale yellow; mediotergite yellow, darkened only on posterior border; knobs of halteres pale yellow; wings with a very faint brown tinge, the cord and extreme wing tip darkened; cell M_1 short-petiolate; abdomen yellow, the tergites with an interrupted series of median spots; hypopygium pale; eighth sternite with a long, pale, compressed, median blade; outer dististyle attenuated.

Male.—Length, about 9 millimeters; wing, 9.6.

Frontal prolongation of head yellow, only weakly darkened above; nasus elongate, reddish brown, tufted with long black setæ; palpi dark brown. Antennæ with scape light yellow, pedicel and flagellum dark brown; antenna moderately elongate, if bent backward extending to shortly beyond base of abdomen; flagellar segments moderately incised, the verticils shorter than the segments. Head yellow, the vertical tubercle clearer yellow; no sign of orbital darkening; occipital brand very small, scarcely apparent against the ground color.

Pronotum and propleura entirely pale yellow. Mesonotum pale yellow, the præscutum with three polished black stripes, the lateral pair strongly outcurved, almost reaching the lateral margin; scutum pale yellow, the lobes extensively variegated with black, the color broadly confluent across the suture with the lateral præscutal stripes; scutellum brownish black, the parascutella light yellow; mediotergite entirely pale yellow, unmarked except for the usual paired darkened spots at posterior border. Pleura pale yellow, variegated with more reddish on the anepisternum, the ventral sternopleurite, and as a semicircular area on the pleurotergite. Halteres dusky, the apices of the knobs

pale yellow. Legs with the coxæ and trochanters yellow; femora and tibiæ brownish yellow, the tips not or only very narrowly darkened; tarsi black. Wings (Plate 1, fig. 21) relatively narrow, with a very faint brown tinge; stigma oval, relatively dark brown; very narrow dark clouds on anterior cord and m-cu; wing tip very narrowly darkened; veins dark brown. Venation: Sc_1 barely indicated; Sc_2 ending just before origin of Rs, the latter subequal to R_{2+3}; cell M_1 short-petiolate; M_4 arising some distance before departure of vein M_3; m-cu a short distance before fork of M.

Abdomen yellow, the tergites with an interrupted median stripe, appearing as broad, dark brown, posterior triangles, on the outer segments small and inconspicuous; tergites very vaguely darkened on lateral portion; sternites and hypopygium pale. Male hypopygium with the tergite (Plate 4, fig. 47, *9t*) extended into a slender, gently curved arm on either side, each bearing a tooth at near midlength of mesal face and a group of four or five others at base; intermediate spinous lobes of tergite truncated at tips, lying close together. Outer dististyle, *od*, long-attenuate, the base relatively broad. Inner dististyle, *id*, bidentate at apex of beak, one point being blackened, the other pale. Membrane between eighth and ninth sternites produced ventrad and slightly cephalad into a long, pale, compressed lobe, narrowed to the tip, the surface microscopically setulose; upon dissection, this blade is seen to be a part of the eighth sternite and is removed with it.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, August 22, 1929 (*Franck*).

The present species is very distinct in the details of coloration and structure of the male hypopygium, notably the long-attenuated outer dististyles and the pale median lobe of the eighth sternite. The structure of the hypopygium is somewhat as in the otherwise very different *Nephrotoma ligulata* Alexander (Mongolia).

NEPHROTOMA DECREPITA sp. nov. Plate 1, fig. 22; Plate 4, fig. 48.

General coloration yellow; præscutal stripes black, the surface weakly pitted to appear only feebly shining; occipital brand dark brown, poorly delimited; terminal segment of maxillary palpus orange-yellow; central portion of mediotergite darkened; legs and halteres chiefly yellow; wings subhyaline, stigma pale brown, cell Sc light yellow; abdomen orange, the tergites with

an interrupted median series of brown spots; hypopygium pale; ninth sternite with two ventral lobes.

Male.—Length, about 11 millimeters; wing, 10.

Frontal prolongation of head obscure yellow, the dorsal surface weakly infumed; nasus a little darker; palpi with basal three segments chiefly brown, the terminal segment paling to orange-yellow. Antennæ moderately elongate, if bent backward extending to shortly beyond the base of abdomen; scape and pedicel yellow, flagellum black; flagellar segments moderately incised; verticils shorter than the segments. Head yellow, the occipital brand dark brown, of moderate size, poorly delimited especially at anterior end; orbital spots barely evident.

Pronotum clear yellow, the lateral portions infuscated. Mesonotal præscutum yellow, with three black stripes, the surface weakly pitted and thus only feebly shining; stripes very narrowly bordered by more velvety black; a paler brown spot at anterior end of lateral stripe; scutum yellow, the lobes extensively blackened; lateral end of suture and outer corner of scutal lobe darkened; scutellum blackened, parascutella yellow; mediotergite light yellow, with a broad, median, brown area, more expanded at posterior border. Pleura yellow, variegated with more reddish yellow on anepisternum, ventral sternopleurite, and ventral meron; dorsal pleurotergite reddish, the lower edge of the ventral pleurotergite narrowly dark brown. Halteres almost uniformly yellow throughout. Legs with the coxæ and trochanters yellow; femora and tibiæ obscure yellow, the tips not or scarcely darkened; basitarsi yellowish brown, passing into brownish black; remainder of tarsi black. Wings (Plate 1, fig. 22) subhyaline; stigma pale brown; cell Sc and prearcular field light yellow; veins brown. Venation: Sc_1 lacking; cell M_1 sessile; M_4 departing some distance before base of cell 1st M_2; m-cu on M_4 shortly beyond origin.

Abdominal tergites orange, with a broken series of brown spots, interrupted at the incisures; sternites and hypopygium pale, the eighth sternite darkened subbasally. Male hypopygium with the tergite (Plate 4, fig. 48, 9*t*) produced into two strongly divergent horns, at base of their mesal face with four or five blackened points; mesal lobes unusually slender, with abundant black spicules. Outer dististyle relatively small and slender, the tip not long-produced. Inner dististyle, *id*, with apical beak slender. Ninth sternite produced ventrad into a stout, fleshy, pale lobe; extreme posterior border of sternite with a median

ligulate darkened lobe that in a position of rest lies cephalad along the surface of the eighth sternite. This appendage appears to arise from the membrane between the eighth and ninth sternites but upon dissection actually comes from the posterior border of the ninth.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 15, 1929 (*Franck*).

As is usual in the genus, the chief characters for defining the present fly lie in the details of structure of the male hypopygium, especially the ninth tergite, the inner dististyle, and the peculiar lobes of the ninth sternite, the last being quite different from that of regional species.

NEPHROTOMA BIFORMIS sp. nov. Plate 1, fig. 23; Plate 4, fig. 49.

Sexes strongly dimorphic in color; males chiefly black, variegated with yellow; abdomen blackened, without reddish color; femora yellow basally, with approximately the outer half blackened; wings beyond base with a faint yellow tinge; females with only the extreme tips of femora blackened; wings uniformly and deeply tinged with amber yellow; abdomen extensively brick red; male hypopygium with a bidentate plate on caudal margin of eighth sternite.

Male.—Length, 13 to 14 millimeters; wing, 11 to 12.

Female.—Length, 15 to 17 millimeters; wing, 12 to 13.

Male.—Rostrum entirely black, including nasus and palpi. Antennæ black throughout, relatively short, if bent backward extending to about midway between the roots of the wings and halteres; flagellar segments scarcely incised; longest verticils shorter than the segments. Front deep yellow, the anterior vertex orange, the entire posterior vertex and occiput black, the occipital brand more opaque, the remainder of the darkened area more velvety; a black spot on anterior orbits opposite the narrowest point; in cases, a yellow area on posterior gena beneath eye.

Pronotum black, broadly yellow medially. Mesonotal præscutum black, the stripes more glabrous, the interspaces deep velvety black; a large, nearly circular yellow area on humerus; lateral border before suture obscure yellow; scutum black, the median portion narrowly pale yellow; scutellum and mediotergite black, the latter restrictedly obscure yellow on sides. Pleura black, variegated with yellow on the pleurotergite and very obscurely on the anepisternum and pteropleurite. Halteres

dusky, the knobs black. Legs with the coxæ dull black, pruinose; trochanters obscure yellow; femora yellow basally, with approximately the outer half or less black; tibiæ brown basally, passing into black; tarsi black. Wings (Plate 1, fig. 23) with a faint yellow tinge; stigma oval, dark brown; prearcular region and cells Sc and Cu_1 light yellow; a restricted dark seam on anterior cord; extreme wing tip very insensibly darkened; veins black, more flavous in the yellow areas. Venation: Sc_2 ending opposite or just beyond origin of the short Rs; cell M_1 sessile; M_4 variable in position, usually departing some distance before M_3, but in cases at this point; m-cu at or a short distance before the fork of M_4.

Abdomen almost entirely blackened; pruinose, without reddish coloration; extreme lateral borders of tergites and caudal margins of sternites pale yellow; hypopygium black. Male hypopygium with the tergite (Plate 4, fig. 49, *9t*) produced into two flattened lobes that are separated by a narrow notch, the mesal edges of the lobes with slender spines and stout spinous setæ. Outer dististyle, *od,* relatively narrow, not greatly attenuated. Inner dististyle, *id,* with the margin having a series of more than a score of long erect setæ, the shorter ones more distad. Eighth sternite tranverse, the caudal margin beneath with a depressed lobe, *8s,* that terminates in two acute black lateral spines, separated by a U-shaped emargination.

Female.—Like the male, differing as follows: Antennal scape yellow to obscure yellow. Femora and tibiæ yellow, the tips narrowly blackened. Wings strongly suffused with amber yellow, much deeper in color than in male. Abdomen chiefly brick red, the tergites velvety black medially, with very broad lateral margins of the ground color, the sixth and succeeding segments almost uniformly reddish; basal tergite uniformly blackened, pruinose; the remaining tergites with pruinose lateral margins; sternites red, the lateral borders narrowly black.

Habitat.—China (Szechwan).

Holotype, male, O-Er, 26 miles north of Li-Fan, altitude 9,000 feet, August 6 to 16, 1933 (*Graham*). Allotopotype, female, August 17, 1933. Paratopotypes, 4 males, 8 females, August 6 to 18, 1933. Paratypes, 1 female, near Tang-Gu, altitude 14,000 feet, August 3 to 6, 1930 (*Graham*); 1 male, Mu-Sang-Tsai, altitude 8,000 to 10,000 feet, July 27 to 28, 1933 (*Graham*).

The only other regional species with which the present fly may be confused is *Nephrotoma erebus* Alexander (Mongolia), which

has the black coloration even more extensive, including the whole head, and with the hypopygial structure different.

NEPHROTOMA OMEIANA sp. nov. Plate 1, fig. 24; Plate 4, fig. 50.

Allied to *palloris;* antennæ (male) relatively elongate, the flagellar segments weakly bicolorous; occipital brand small and inconspicuous; mesonotal præscutum with three brown stripes; lateral ends of suture velvety back; scutellum and central portion of mediotergite broadly pale; tips of femora narrowly blackened; wings cream-colored, variegated with brown; a conspicuous pale area beyond the stigma; m-cu far before fork of M_4; abdominal tergites trivittate with brownish black, the stripes interrupted; male hypopygium with the outer dististyle small, not attenuated.

Male.—Length, 12.5 to 13.5 millimeters; wing, 10.5 to 11.5; antenna, 5 to 5.2.

Female.—Length, 17 to 18 millimeters; wing, 13 to 14.

Frontal prolongation of head obscure yellow, polished; nasus long-tufted, somewhat darker; palpi dark brown, the central portion of the terminal segment more yellowish. Antennæ (male) relatively elongate, as shown by the measurements; basal three segments yellow; succeeding flagellar segments bicolorous, brownish black, the outer ends of the segments narrowly yellow, the basal enlargements a little more intensely black; outer segments more uniformly darkened; flagellar segments rather strongly incised; terminal segment small, thimble-shaped. Head orange; occipital brand small, pale brown, inconspicuous.

Pronotum obscure yellow, a little darker on sides. Mesonotal præscutum yellow, with three brown stripes, their surface subnitidous, without darker margins; lateral stripes straight; scutum broadly yellow medially, the lobes entirely black; lateral ends of suture and extreme anterolateral corners of scutal lobes narrowly velvety black, forming a strongly curved mark; scutellum pale, parascutalla dark; mediotergite broadly pale yellow medially, darker laterally and behind. Pleura pale yellow, darker, more reddish, on the anepisternum and sternopleurite, forming an oblique or transverse girdle across mesopleura. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ obscure yellow; trochanters yellow; femora yellow, the tips very narrowly but conspicuously blackened; tibiæ yellowish brown, brighter basally, the tips darkened; tarsi passing through brown to black. Wings (Plate 1, fig. 24) with the ground pale cream colored; prearcular region darkened; cell Sc

dark brown, C more brownish yellow; stigma oval, dark brown; wing tip broadly and conspicuously darkened, the color extending from cell R_2 to cell M_3, separated from the dark stigmal area by a pale marking in cells Sc_2 and R_2; anterior cord and m-cu conspicuously seamed with brown; distal section of Cu_1 less conspicuously seamed with brown; veins dark brown. Venation: Sc_2 ending opposite the short Rs, Sc_1 represented by a short spur; cell M_1 petiolate; cell 1st M_2 relatively small; m-cu some distance before fork of M_4.

Abdomen (male) elongate, yellow, the tergites narrowly trivittate with brownish black, the median stripe interrupted basally, the lateral stripes subbasally, on each segment; sternites yellow, narrowly darkened medially, more extensively so on the outer segments, the incisures pale; hypopygium yellow. Male hypopygium relatively large; tergite (Plate 4, fig. 50, *9t*) proportionately small, gradually narrowed outwardly, with blackened spiculose points on either side of a deep U-shaped median notch but without other armature. Outer dististyle, *od*, small, triangular in outline, the tip not produced. Inner dististyle, *id*, as figured. Eighth sternite narrowly but rather deeply notched, with moderately conspicuous dark brown setæ surrounding the notch, their tips converging.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 14, 1929 (*Franck*). Allotype, female, Chunking, altitude 1,000 to 2,000 feet, May 6 to 27, 1930 (*Graham*). Paratopotype, male, August 10, 1929 (*Franck*). Paratypes, 8 males and females, with the allotype; 2 males, 1 female, Kwanhsien, May 8 to 28, 1930 (*Graham*).

The nearest allies of the present fly are *Nephrotoma palloris* (Coquillett) and *N. sinensis* (Edwards), both of which have the postnotal mediotergite broadly pale, except laterally. The present fly differs most evidently in the three præscutal stripes, pale costal spot beyond the stigma, and the details of structure of the antennæ and male hypopygium.

291593——10

ILLUSTRATIONS

[Legend: *b*, Basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *s*, sternite; *t*, tergite.]

PLATE 1

FIG. 1. *Tipula* (*Brithura*) *argyrospila* sp. nov., venation.
2. *Tipula* (*Brithura*) *fracticosta* sp. nov., venation.
3. *Tipula* (*Nippotipula*) *sinica* sp. nov., venation.
4. *Tipula* (*Sinotipula*) *exquisita* sp. nov., venation.
5. *Tipula* (*Sinotipula*) *gloriosa* sp. nov., venation.
6. *Tipula* (*Formotipula*) *omeicola* sp. nov., venation.
7. *Tipula* (*Formotipula*) *friedrichi* sp. nov., venation.
8. *Tipula* (*Acutipula*) *melampodia* sp. nov., venation.
9. *Tipula* (*Acutipula*) *bistyligera* sp. nov., venation.
10. *Tipula* (*Vestiplex*) *testata* sp. nov., venation.
11. *Tipula* (*Oreomyza*) *famula* sp. nov., venation.
12. *Tipula* (*Oreomyza*) *tetramelania* sp. nov., venation.
13. *Tipula* (*Oreomyza*) *rudis* sp. nov., venation.
14. *Tipula* (*Oreomyza*) *haplorhabda* sp. nov., venation.
15. *Prionocera lætipennis* sp. nov., venation.
16. *Prionocera altivolans* sp. nov., venation.
17. *Nephrotoma retenta* sp. nov., venation.
18. *Nephrotoma attenuata* sp. nov., venation.
19. *Nephrotoma impigra* sp. nov., venation.
20. *Nephrotoma pilata* sp. nov., venation.
21. *Nephrotoma immemorata* sp. nov., venation.
22. *Nephrotoma decrepita* sp. nov., venation.
23. *Nephrotoma biformis* sp. nov., venation.
24. *Nephrotoma omeiana* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Brithura*) *fracticosta* sp. nov., male hypopygium, details.
26. *Tipula* (*Brithura*) *fractistigma* Alexander, male hypopygium, dististyle.
27. *Tipula* (*Nippotipula*) *sinica* sp. nov., male hypopygium, details.
28. *Tipula* (*Sinotipula*) *exquisita* sp. nov., male hypopygium, details.
29. *Tipula* (*Sinotipula*) *gloriosa* sp. nov., male hypopygium, details.
30. *Tipula* (*Sinotipula*) *gloriosa* sp. nov., male hypopygium, dististyles.
31. *Tipula* (*Sinotipula*) *persplendens* sp. nov., male hypopygium, dististyles.
32. *Tipula* (*Formotipula*) *friedrichi* sp. nov., male hypopygium, details.
33. *Tipula* (*Acutipula*) *melampodia* sp. nov., male hypopygium, ninth tergite.
34. *Tipula* (*Acutipula*) *melampodia* sp. nov., male hypopygium, details.

PLATE 3

FIG. 35. *Tipula* (*Acutipula*) *bistyligera* sp. nov., male hypopygium, details.
36. *Tipula* (*Vestiplex*) *testata* sp. nov., male hypopygium, details.
37. *Tipula* (*Oreomyza*) *famula* sp. nov., male hypopygium, details.
38. *Tipula* (*Oreomyza*) *tetramelania* sp. nov., male hypopygium, details.
39. *Tipula* (*Oreomyza*) *rudis* sp. nov., male hypopygium, details.
40. *Tipula* (*Oreomyza*) *rudis* sp. nov., male hypopygium, details.
41. *Prionocera lætipennis* sp. nov., antenna, male; basal six segments.
42. *Prionocera lætipennis* sp. nov., male hypopygium, details.

PLATE 4

FIG. 43. *Nephrotoma retenta* sp. nov., male hypopygium, details.
44. *Nephrotoma attenuata* sp. nov., male hypopygium, details.
45. *Nephrotoma impigra* sp. nov., male hypopygium, details.
46. *Nephrotoma pilata* sp. nov., male hypopygium, details.
47. *Nephrotoma immemorata* sp. nov., male hypopygium, details.
48. *Nephrotoma decrepita* sp. nov., male hypopygium, details.
49. *Nephrotoma biformis* sp. nov., male hypopygium, details.
50. *Nephrotoma omeiana* sp. nov., male hypopygium, details.

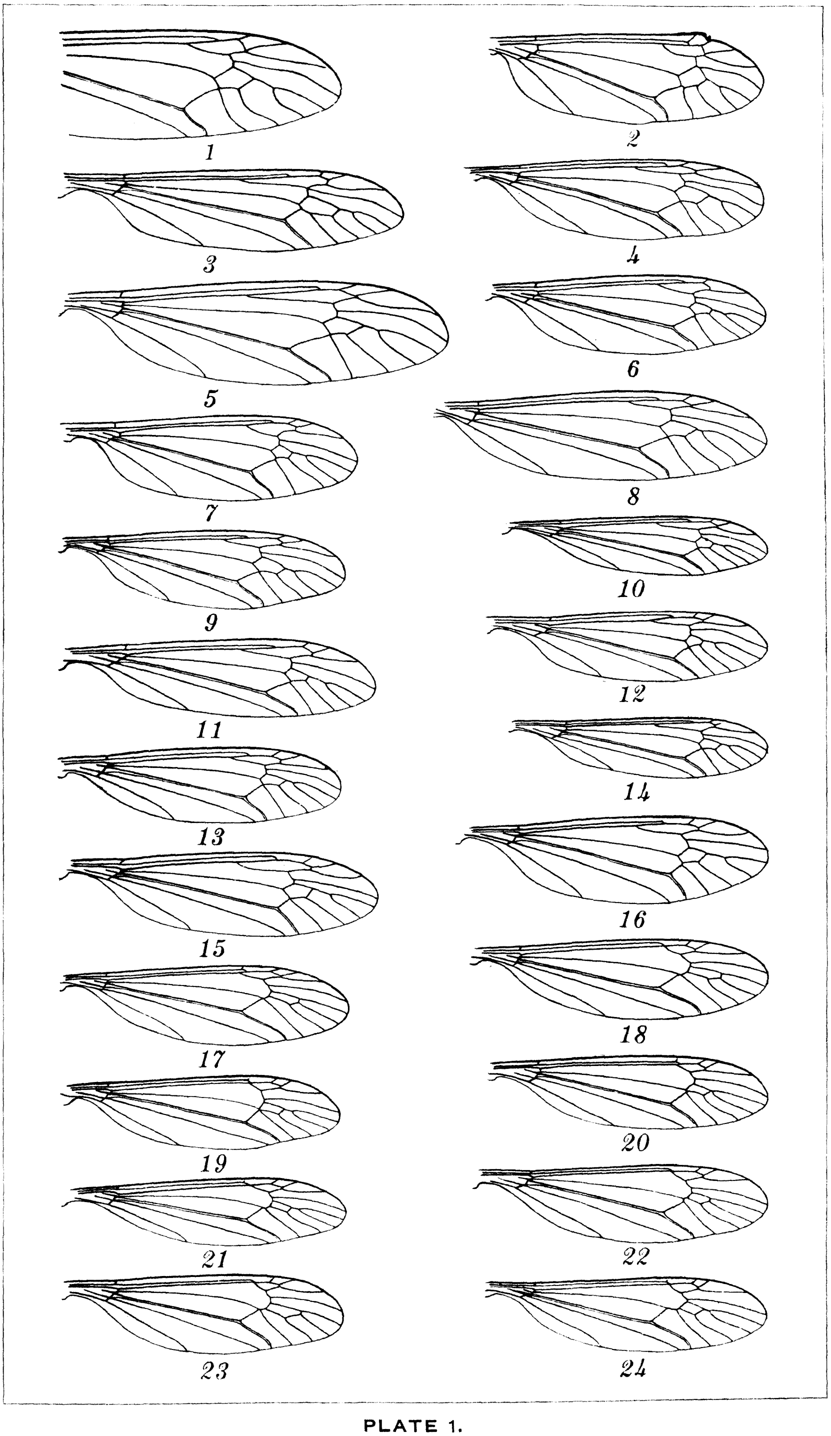
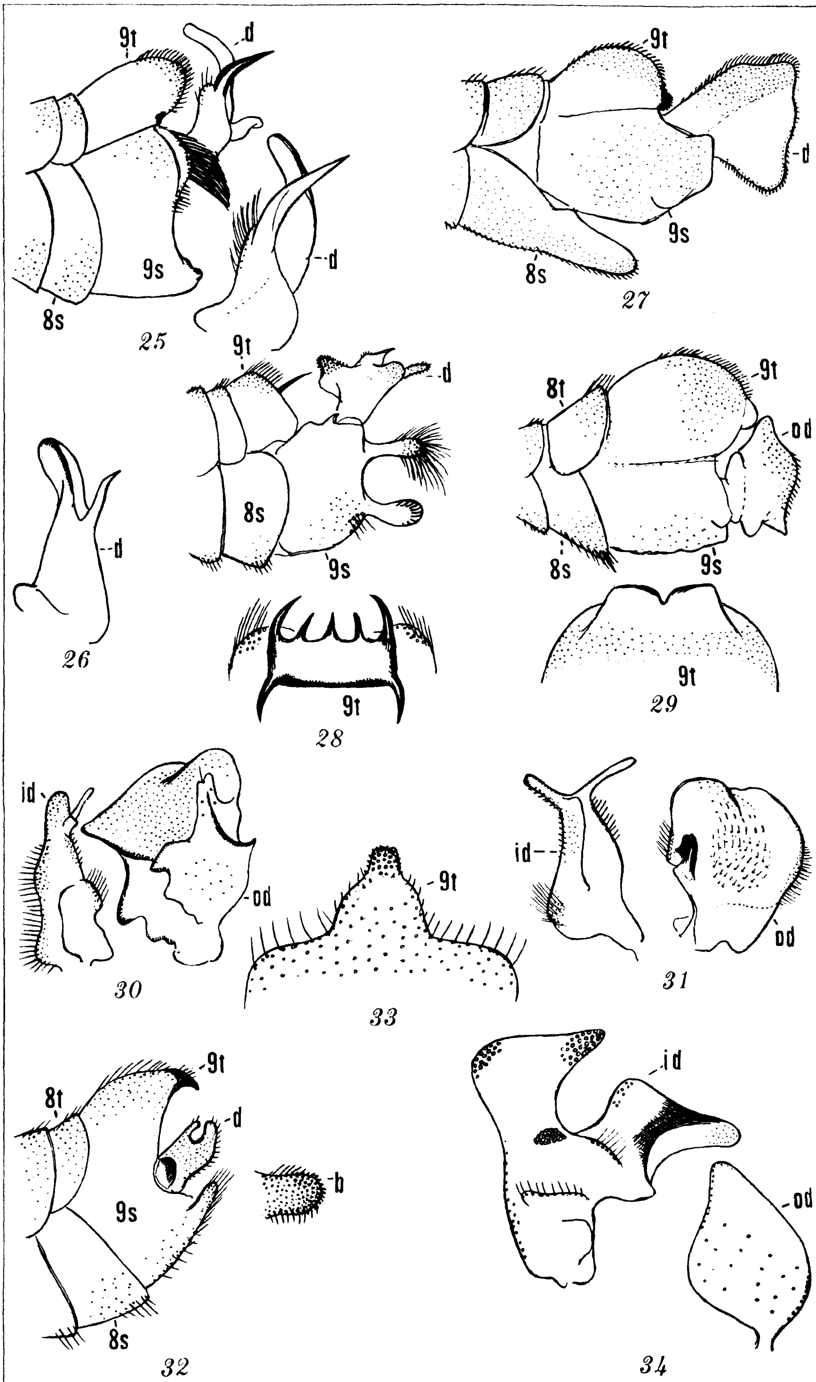


PLATE 1.



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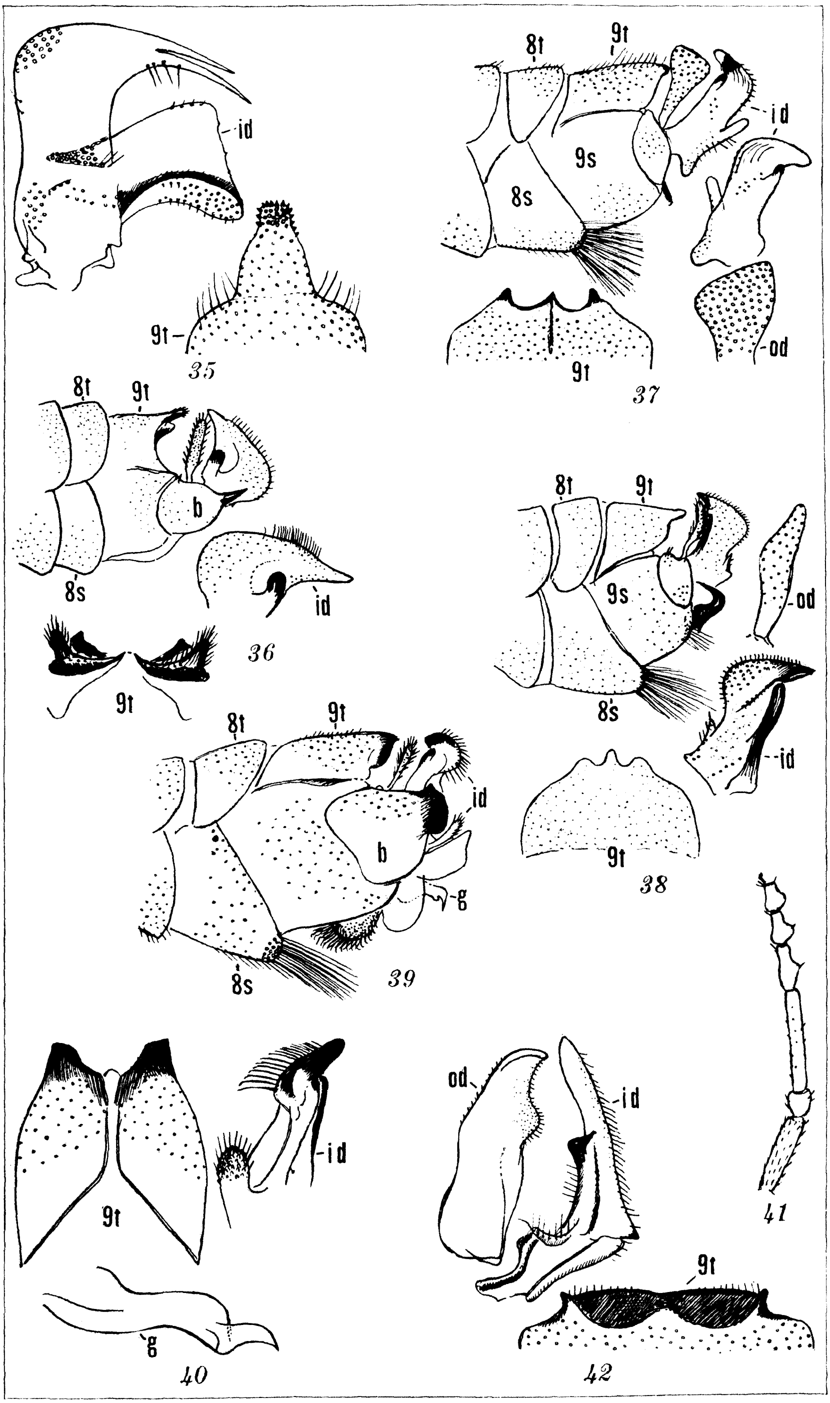
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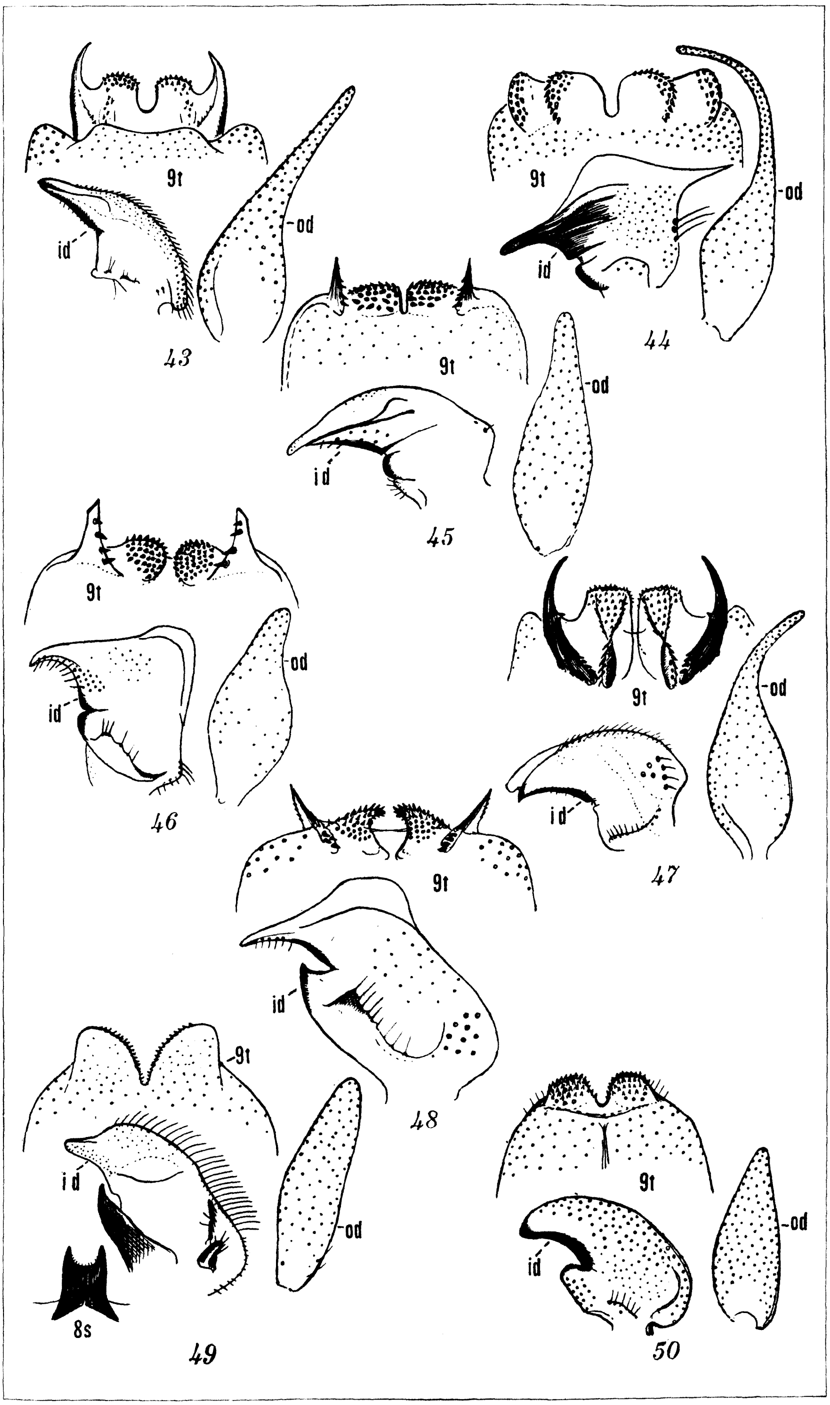
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PLATE 4.

THE PHILIPPINE BUREAU OF SCIENCE

THE PHILIPPINE JOURNAL OF SCIENCE

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Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 302, Manila, P. I., or to any of the agents listed below.

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CONTENTS

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 57, NO. 2 JUNE, 1935

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1935

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 57 JUNE, 1935 No. 2

A GENETIC STUDY OF CERTAIN CHARACTERS IN VARIETAL HYBRIDS OF COWPEA[1]

By JOSÉ M. CAPINPIN

Of the Department of Agronomy, College of Agriculture
University of the Philippines, Los Baños

ONE PLATE

INTRODUCTION

There are two local types of *Vigna sinensis* Endl. in Luzon; these are known as "sitao" and "paayap." Sitao (sometimes called *V. sesquipedalis* Fruw.) is the long-podded pole-bean type. Paayap is the bushy type with an erect vine. The cowpea varieties of the latter type are discussed in this paper. The cowpea plant is considered valuable as a soil renovator, as a green manure, and as a forage crop. In home gardens the paayap is raised for its green peas and pods for the table. Because of its agricultural uses and economic utility the paayap merits the attention of plant breeders and geneticists in efforts for its improvement.

The present work was undertaken to study the inheritance of the flower, seed-coat, and pod characters of cowpea in connection with an attempt to produce and develop a hybrid that would combine the desirable characters of both the imported and the native Philippine varieties. It became apparent in the course of the experiments that certain phenomena observed in this common plant offer a clear illustration of the laws of heredity.

[1] Experiment Station, College of Agriculture contribution 1037. Read before the Los Baños Biological Club January 24, 1935, and the Third Philippine Science Convention February 26, 1935.

This paper presents a description of the first hybridization work in this leguminous crop and an account of the mode of inheritance of factors affecting the colors of flower, seed coat, and pod, as well as the agronomic value and general hybrid behavior of the crosses produced.

The experiments described herein were begun in January, 1932, and were closed in January, 1935. The experimental cultures were conducted in the plant-breeding nursery and in the breeding plots on the experiment-station farm of the Department of Agronomy, College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

Varieties of cowpea used.—The cowpea varieties differ in several agronomic characters, such as growth habit, size, prolificacy, and disease resistance. In color of seed coats they may be either variously blotched, speckled, and mottled or unicolored. The unicolored types are red, buff, black, grayish blue, creamy white, or white. The varieties used in these experiments, the New Era and the White Paayap, fall under the unicolored groups, and possess contrasting colors of flowers and seed coats.

The White Paayap is supposedly an indigenous variety of cowpea, which has yellowish or creamy white flowers and seed coats. It is a hardy, although not prolific, cowpea and possesses desirable culinary qualities, such as finer texture of pods and a smaller amount of fiber than the New Era variety.

The New Era variety, according to available records in the Department of Agronomy, is one of the several cowpeas introduced at this college in 1912 from the United States Department of Agriculture. It proved to be the only successful introduction. The seed coat is deep blue with innumerable minute blue specks on a gray background. It is an erect bushy plant, rarely having prostrate branches like the White Paayap variety. The flower is pale purple. New Era is an earlier flowering and maturing variety than the White Paayap. Although a prolific variety, it does not find favor as a vegetable, for the green pods are more hairy and fibrous than those of the other varieties.

Test and selection of parent varieties.—To insure the purity of the parent plants used in this work, preliminary tests were made to isolate pure races of both the White Paayap and New Era varieties. These tests were made by planting and harvesting

the two varieties in two separate lots for two seasons. The two varieties were grown very far apart; one, the New Era variety, was grown near the border fence of the plant-breeding nursery back of the agronomy main building, and the White Paayap variety was grown on one of the lots on the experiment-station farm. This procedure was adopted to minimize, if not entirely avoid, accidental mixture arising through natural cross-pollination. No other cowpeas were grown in the immediate vicinity of the lots where the two varieties were grown. In the first culture, the seeds of both varieties were planted January 4, 1932, and the pods harvested March 20 to April 27, 1932. To insure the use of one-line parentage, only pods gathered from one plant were grown in the next planting. The seeds from the first culture were sown June 8, 1932, and the pods harvested October 14 to 22, 1932. The uniformity observed in the color of the seeds and flowers served as a criterion of the apparent purity of the parental varieties tested.

Planting and flowering of parent varieties.—The seed materials intended for parent types were taken from the harvest of the second culture and both grown in the breeding plots of the experiment station. In order that the flowering periods of the two varieties would coincide, the New Era, the earlier of the two varieties, was planted later than the White Paayap. The planting was as follows:

Variety.	Date of planting.	Date of flowering.
White Paayap	July 25, 1933	October 15 to 20, 1933.
New Era	August 1, 1933	September 19 to October 27, 1933.

Technic of crossing.—Of the legumes with hermaphroditic flowers the cowpea is one of those with the largest blossoms. Its flower has ten stamens and one pistil inclosed in one floral envelope. In cross-pollination work with the cowpea, therefore, emasculation is necessary; this should be done at the bud stage. Preliminary observations are necessary to judge the age of the bud, when its own pollen has not yet been shed. The cowpea is a naturally self-fertilizing plant where dehiscence may even be completed before anthesis takes place. An unopened flower bud is triangular in form. To emasculate, a flower bud is held between the thumb and forefinger with its keel side at the top, then

a needle is run along the ridge where the edges of the petals unite. A slit is made a little below the keel, exposing the ten unexpanded stamens. With a pair of small forceps the filaments of the stamens are pulled out. They are counted as they are removed to make certain that none is left. The emasculated flowers are inclosed in a waxed or paraffine paper bag, or sometimes only covered with a leaf folded once and secured in position with a pin or a little splinter like a toothpick. In these experiments emasculation was sometimes accompanied by pollination on the same day or, if not, pollination was done on the following day. When emasculation and pollination were done simultaneously, the operations were performed at any time between 9 and 11 o'clock in the forenoon. When the flowers were emasculated in the afternoon, between 2 and 4 o'clock; pollen was applied the following morning. In all cases the parental types involved in the mating had been previously bagged.

The success or failure of artificial pollination was indicated by the appearance of the cross-fertilized flowers and by their adherence to the plants for some time. Unsuccessful fertilization was indicated by the falling off of the flowers as early as twelve hours after pollination. Generally, after a lapse of forty-eight hours after pollination, a small green structure of the pod became evident, as an indication of the successful setting of the pods.

Culture of Vigna hybrids.—The cross-pollinated seeds and their subsequent generations were planted and harvested as follows:

Seed material.	Planted.	Flowered.	Harvested.
F_1 hybrid	Dec. 2, 1933	Jan. 6, 1934	February to March, 1934.
F_2 hybrid	July 6, 1934	Aug. 10, 1934	September to October, 1934.
F_3 hybrid	Nov. 18, 1934	Dec. 27, 1934	January 5, 1935.

DISCUSSION AND RESULTS

Cross-pollination of cowpeas.—In Table 1 are shown the results of artificial crossing of cowpeas. At least 40 per cent of the flowers mechanically treated and artificially pollinated set pods. This is a fair percentage of success, considering the

TABLE 1.—*Results of cross-pollinating New Era and White Paayap varieties of cowpeas.*

Parental types.	Date of pollination.	Flowers treated.	Harvested.	Pollinated pods harvested.	
					Per cent.
White Paayap × New Era	Oct. 21, 1933	6	Nov. 15, 1933	6	100
Do	Oct. 23, 1933	9	Nov. 18, 1933	7	77
Do	Oct. 23, 1933	10	Nov. 18, 1933	4	40
New Era × White Paayap	Oct. 22, 1933	9	Nov. 14, 1933	5	55
Do	Oct. 26, 1933	6	Nov. 27, 1933	3	50
Do	Oct. 27, 1933	12	Nov. 29, 1933	5	42

weather and climatic conditions, such as unexpected rainfall and cooler days, which prevailed during the course of pollination experiments. The difficulty met with in synchronizing the flowering accounted for some low percentages of success in pollination. In these experiments it was observed that while one variety was at its height in flowering the other had passed the midperiod of its blooming. The pods harvested in the initial pollination work gave about ninety-eight plants for first-generation planting. In general, it may be stated that the cowpea is quite suitable material for hybridization because of the convenient size of its flower for hand manipulation.

Inheritance of flower color.—As mentioned elsewhere, the two varieties, White Paayap and New Era, possess contrasting colors, and offer suitable material for observation of hybrid and other genetic phenomena. The first-generation hybrid plants of the cross New Era and White Paayap were all purple-flowered. These F_1 purple-flowered plants, when pollinated inter se, gave in the F_2 generation only two phenotypic flower colors. Table 2 shows the segregation of flower colors in the F_2 hybrid population. Of the 478 plants in the whole population, 365 were purple-flowered and 113 white-flowered. The segregation suggests a monohybrid Mendelian ratio of 3:1. However, the goodness of fit of the observed ratio was tested not only for the 3:1 ratio but also for the dihybrid ratios 13:3 and 9:7, and the trihybrid ratio 37 : 27. After calculating the expected numbers of individuals, deviations, and probable errors, and testing the closeness of fit, it was concluded that the purple flower of the New Era is dominant to the white flower of the White Paayap and the segregation observed follows a simple Mendelian

TABLE 2.—*The Mendelian segregation of purple and white flowers in an F_2 Vigna hybrid population.*

Factorial basis.	Ratio.		Plants.					
	Observed.	Expected.	Observed.		Calculated.		Deviation.	Probable error.
			Purple.	White.	Purple.	White.		
Monogenic (normal)	3.05 : 0.95	3 : 1	365	113	385.5	119.5	6.50	6.39
Digenic (modified)	12.24 : 3.76	13 : 3	365	113	382.0	96.0	17.00	5.76
Do	12.24 : 3.76	9 : 7	365	113	269.0	209.0	96.00	7.32
Trigenic (modified)	48.80 : 15.20	37 : 27	365	113	260.7	217.3	104.30	7.28

monohybrid ratio (Plate 1). The flower-color segregation herein reported found corroboration in the work of Harland,(1) who concluded that the F_2 segregation of flower color in cowpea was rather simple. He reported that in the crosses dark × pale, the F_2 segregation was the simple Mendelian one of 3 dark to 1 pale and concluded that these colors constitute an allelomorphic pair. This was also true in the cross dark × white. Harland's results of the cross pale × white were, however, explained by the assumption that the flower color is due to interaction of two factors.

Inheritance of seed-coat color.—The New Era seed coat, although characterized by minute specks on a dark gray background, is considered unicolored, for the deep blue predominates, appearing as a solid blue color. The White Paayap seed coat is creamy or yellowish white. For convenience the New Era seed-coat color is described as grayish blue or blue, and that of White Paayap as white. The F_1 plants of the original cross were all blue. In the F_2 population the seed-coat colors segregated into three phenotypes; blue, brown, and white. Of the 282 individuals, 165 were blue-seeded, 29 brown-seeded, and 88 white-seeded (Table 3). The situation appears different from that which had been observed in flower-color segregation. The calculated number of the phenotypes on the basis of two-factor inheritance, with a ratio of 9 : 3 : 4, closely approximates the blue and white classes, with slight deficiency in the brown class. The observed segregation was not compared and the closeness of fit tested with segregating ratios on the basis of more than two factors. Assuming that two genes are involved in the inherit-

TABLE 3.—*The Mendelian segregation of seed color in an F_2 Vigna hybrid population.*

Family.	Plants.	Color of seeds.	Total.	Calculated.	Ratio. Expected.	Ratio. Calculated.	±E
PWSB (1)	105	Blue	165	158.6	9	9.37	0.3372
PBSB (1)	60						
PWSB (2)	15	Brown	29	52.8	3	1.65	0.2698
PWSB (3)	14						
PWSB (4)	19	White	88	70.6	4	4.98	0.2630
PWSW	12						
PBSW	31						
PBSB (2)	26						
Total	282		282	282.0	16	16.00	

ance of seed color the theoretical considerations of the cross would seem to be as follows:

B, basic factor for pigmentation; *b*, absence, and recessive factor of *B*; *C*, modifying factor, which in the presence of and reacting with *B*, would give blue; *c*, absence of *C*, reacting with *B*, would give brown. The interaction of genes *B* and *C* would give the following phenotypic expression: *BC*, blue; Bc, brown; *bC* and *bc*, white.

In the above assumption the phenotypic proportion of 9 blue : 3 brown : 4 white appears to be sufficiently fulfilled to warrant the statement that the seed-coat color segregation observed in these experiments is governed by interaction of two genes (Plate 1). In this connection it may be mentioned that Harland(2) working with several colored cowpea varieties reported the following:

(*a*) Red × white. F_1 buff; segregating in F_2 into 9 buff : 3 red : 4 white.

(*b*) Black × white. F_1 black; segregating in F_2 into 9 black : 3 buff : 4 white.

(*c*) New Era × black. F_1 black; segregating in F_2 into 3 black : 1 New Era.

(*d*) New Era × white. F_1 New Era; segregating in F_2 into 9 New Era : 3 buff : 4 white.

(*e*) Black × buff. F_1 black; segregating in F_2 into 12 black : 3 buff : 1 red.

From the foregoing consideration it can be deduced that certain allelomorphic pairs of seed-coat colors are monogenic in inheritance while other color allelomorphs are digenic or bifactorial in heredity. The cross New Era × white, where F_2 segregation into 9 New Era : 3 buff : 4 white occurred, is similar in nature to the inheritance of seed-coat colors of the White Paayap × New Era cross here reported. The results of both crosses indicate that two factors are involved in seed color and follow a dihybrid segregation.

Relation between seed and flower colors.—An interesting aspect of correlated variability was observed in regard to the color of seed and color of flower. In the study of flower-color segregation, observation was extended to corresponding color of seed coats. Table 4 shows the relationship between these two characters.

TABLE 4.—*The relationship of flower and seed colors in an F_2 Vigna hybrid population.*

Individuals.	Flower pigmentation.	Seed color.
165	Purple	Blue.
29	Do	Brown.
88	White	White.

acters. It was noted that purple-flowered plants developed colored seeds that were either blue or brown and the white-flowered plants formed white seeds. Apparently there was definite correlation between the occurrence of anthocyan in the flowers and the production of seed-coat color. This association was in accord with the constant correlations between blossom colors in the colors of seed coats in many varieties of beans as reported by Shaw,(4) who found that white or eyed bean varieties are always white-flowered or light pink-flowered, while the black wax varieties are always pink-flowered. Spillman,(5) who made some earlier observations on the inheritance of seed-coat color in *Vigna,* found that all varieties of cowpeas having white or cream-colored seeds have white flowers and are devoid of anthocyan in stems and leaves. The genetical mechanism of this association, according to Spillman,(5) may be visualized as follows: "The flower color which is due to an anthocyan, and the anthocyan in stems and leaves are dependent on two Mendelian color factors, one of which, apparently an enzyme, is the general factor for color in the seed coat of the cowpea. The other is the special factor for black which, when added to a variety having

coffee-colored seeds, converts the seed to black." The conclusions of Spillman, in so far as they relate to association between seed coat and flower colors, are applicable to the observation herein reported. Although in this investigation no information was obtained on the distribution of anthocyan in the stems and leaves resulting from gene action affecting flower and seed colors, the relationship between the colors of flower and seed appears to be well established.

Variability and heredity of pod color.—In cowpea varieties the matured pod showed variations in color. This color may be either dark brown, black, or yellowish white. In the hybrid population the pod color showed indication of simple Mendelian inheritance. In Table 5 it can be noted that all families

TABLE 5.—*The segregation of pod color in an F_2 Vigna hybrid population.*

Parental types.		Progeny.		Genetic behavior.
Family.	Pod color.	Individuals.	Pod color.	
PWSB (1)	White	15	White	Homozygous.
PWSB (2)	do	11	do	Do.
PWSW (1)	do	9	do	Do.
PBSB (1)	Black	15	do	Heterozygous.
		16	Black	
PBSB (2)	do	19	do	Homozygous.
PBSB (3)	do	22	do	Heterozygous.
		7	White	
PBSW (1)	do	29	Black	Homozygous.
PBSW (2)	do	18	do	Do.
PBSW (3)	do	28	do	Do.

having white pods produce white pods, while those having black pods either breed true to type, or segregate into black and white types. This merely suggests that the black-podded type behaved as either a homozygous or heterozygous dominant trait, while the white-podded type proved to behave as a recessive character. Family PBSB (1) segregated into 16 black and 15 white, which was very close to a 1 : 1 ratio. On the other hand, the family PBSB (3), which segregated into 22 black and 7 white, approximated a 3 : 1 ratio. All white-podded families PWSB and PWSW, however, produced all white-podded progeny. These true breeding and segregating tendencies of pod color are perhaps explicable on one-factor difference. The black type segregating into 1 black and 1 white may be assumed to be a cross

of heterozygous dominant and homozygous recessive *Bb* × *bb*, giving in the next generation 50 per cent *Bb* and 50 per cent *bb*. The black type segregating into 3 black and 1 white may be assumed to be a selfed heterozygote *Bb*, which should give 75 per cent black (25 per cent *BB* and 50 per cent *Bb*) and 25 per cent *bb*, which is white. Since no black pod appeared in any of the white-podded families, the recessive behavior of the white-pod character seems to be fully demonstrated. Harland(2) reported that the purple color of pod was dominant to its absence or nonpurple class, but the heterozygous lines segregated into a 4 : 1 ratio showing a marked deficiency of the recessive. This marked deficiency in the expected number of recessives led to the conclusion that more than one factor may be involved. Harland then concludes that, while the exact mode of inheritance of purple pod is not fully elucidated, it may be assumed meanwhile that one main factor, *P*, is responsible for the purple pod. It may be remarked here that Harland's purple pod color corresponds to the black pod color referred to in the present discussion, for both the colors apply to the New Era cowpea. The concept that one main factor is responsible for pod coloration appears to be substantiated in the present investigations where 1 : 1 and 3 : 1 segregations were observed.

Linkage relations.—The haploid chromosome number in *Vigna sinensis* Endl. is 12, as given by Kihara et al.(3) and Tschechow and Kartaschowa.(6) This would mean that the maximum linkage groups that could be established in this species would not exceed 12. The present work seems to indicate that a genetic linkage exists between the genes for flower color and seed-coat pattern. It was pointed out that all purple-flowered plants were either blue- or brown-seeded while all white-flowered plants were white-seeded. Furthermore, the genes for white flowers and those for white seeds seem to be closely linked, for in no case did a plant appear showing crossovers; that is, individuals with purple flowers and white seeds or individuals with white flowers and blue seeds. Harland(2) found the genes for black pattern of seed coat, purple pod, and New Era pattern of seed coat linked together, with the genes for black pattern showing repulsion on a basis probably higher than 1 : 15, and the genes for black pattern of seed coat and those for purple pod showing repulsion probably on a basis higher than 1: 7. In the present experiments the apparent linkage between the genes for pod color and seed-coat colors should be very loose, for the relative distribution

that would account for their crossing over or repulsion was in order to simulate independent segregation in inheritance; for in the hybrid population were noted families with white pod-blue seeds, white pod-white seeds, black pod-blue seeds, black pod-white seeds, black pod-brown seeds, and white pod-brown seeds, occurring almost in equal proportions.

Agronomic features of cowpea varieties and their hybrids.—The practical value of hybridizing cowpeas is determined largely by the possibility of securing desirable segregates in the F_2 generation. In agronomic investigations yield is of major interest. Yield is here used with special reference to number of pods produced per plant and number and weight of seeds contained in each pod.

Comparisons of the parental and F_1 and F_2 populations were made on the basis of the mean, the range, and the variability as measured by Weinberg's(7) formula. This formula was adopted because it represents not only a rough measure of the skewness and range of distribution, but also gives an abstract number that is not affected by the magnitude of the mean as is the coefficient of variability.

A comparison of the production of pods per plant of the parental varieties and F_1 and F_2 populations of the hybrids is given in Table 6. The New Era variety and F_1 hybrid population

TABLE 6.—*The comparison of F_1 and F_2 populations with their parent varieties in number of pods per plant.*

	Range.		Mean number of pods per plant.	W
	Minimum.	Maximum.		
White Paayap	3	27	9.96±0.89	0.704
New Era	3	33	12.24±1.14	0.607
F_1 hybrid	3	33	10.62±1.03	0.680
F_2 hybrid	3	31	11.00±0.93	0.670

showed a similar range in the number of pods produced per plant. The White Paayap proved to be a lower producer of pods than the New Era, whereas the F_2 hybrid segregate was almost intermediate between the two parents. The maximum variate of F_1 was higher than the maximum of the White Paayap parent but equal to that of New Era's maximum. That of the F_2 segregate was also higher than that of the White Paayap, but a little lower than that of the New Era's. The New Era

cowpea, with a mean of 12.24 ± 1.14 pods per plant, was a heavier producer than the White Paayap, which gives a mean of 9.96 ± 0.89 pods per plant. The F_1 hybrid produced 10.62 ± 1.03 pods per plant, which is a little higher than the lower parental type, but lower than the higher parental type. The F_2 segregate, with a mean of 11.00 ± 0.93 pods per plant, fell just between the means of the parental types. Statistically considered, however, the mean difference was not significant.

The variability relationships in number of pods produced per plant of the parental and hybrid types appear to agree quite closely. The White Paayap parent exhibited a degree of variability a little higher than the New Era parent and almost equal to those of the F_1 and F_2 populations.

The number of seeds contained in each cowpea pod refers to number of sound seeds; that is, undeveloped or aborted seeds are excluded. If the number of pods and size of seed were constant, the yield per plant would be dependent upon the number of seeds produced per pod. An increase in the number of seeds produced per pod would tend to increase plant production. The variability in number of seeds per pod as determined in the parental and F_2 hybrid segregate types is shown in Table 7.

TABLE 7.—*The comparison of an F_2 hybrid-brown segregate with its parents in number of seeds in each pod.*

Variety.	Range.		Mean number of seeds.	W
	Minimum.	Maximum.		
White Paayap	4	18	13.65±0.144	0.756
New Era	4	21	13.90±0.172	0.740
Hybrid Brown	3	20	13.44±0.178	0.670

In this determination data were not obtained on the F_1 hybrid type, for the comparison was made between the parent varieties and the F_2 hybrid, brown-seeded segregate, which was considered a novel type, or a new variety. The White Paayap parent had a range of 4 to 18 seeds per pod with a mean of 13.65 ± 0.144; the New Era variety, a range of 4 to 21 with a mean of 13.90 ± 0.172; and the F_2 hybrid segregate, a range of 3 to 20 with a mean of 13.44 ± 0.178. Statistically treated, the yield of the hybrid compared favorably with that of either parent variety, especially when the number of seeds produced per pod was con-

sidered. The variation in size of seeds as measured by the average weight of ten seeds is shown in Table 8. The average weight

TABLE 8.—*The comparison of an F_2 hybrid-brown segregate with its parents in weight of ten seeds.*

	Range.		Mean weight of ten seeds.	W
	Minimum.	Maximum.		
	g.	g.	g.	
White Paayap	0.3	1.5	0.788 ±0.025	0.825
New Era	0.5	1.5	0.936 ±0.022	0.740
Hybrid Brown	0.2	1.5	0.978 ±0.023	0.530

per ten seeds of White Paayap was 0.788 ±0.025 gram; New Era, 0.936 ± 0.022; and the F_2 hybrid-brown segregate, 0.978 ± 0.023. The Hybrid Brown seeds clearly weigh more than either of the parents. The variability relationship for number and weight of seeds appears to be constant. For these two characters the Hybrid Brown exhibits invariably the least degree of variation. The White Paayap in both cases excels to a slight degree the variation shown by the New Era. Biometrically the difference between the mean of New Era and White Paayap and that of Hybrid Brown and White Paayap was significant. Therefore, the Hybrid Brown cowpea, in so far as weight of seeds is concerned, constitutes an improvement on the White Paayap variety.

The isolation of pure race of the hybrid was tested by sowing a random sample of seeds from its five families November 18, 1934. Flowering commenced December 27, 1934. The pods matured January 5, 1935. Of the five families of brown-seeded hybrid four, which proved to be the homozygous genotype of brown-seeded type, produced all brown-seeded plants. One family segregated into brown- and white-seeded progeny. No statistical counts of brown- and white-seeded types were made, for the appearance of brown-and-white biotypes is taken as a confirmation of the action of the genes assumed in the inheritance of seed-coat pattern. Since homozygous lines of Hybrid Brown were already identified by breeding, the multiplication of this Hybrid Brown type would merely consist of planting them on a large scale. The hybrid type merits testing to prove whether or not it is as hardy as the White Paayap parent and as prolific as

the New Era. For culinary purposes it would seem that the amount of anthocyan in the seeds counts as an advantage, for this would lessen the colored fluid that darkens the water when the peas are boiled. The isolated Hybrid Brown represents the hardiness and habit of growth of the White Paayap parent and the prolificness and flower color of the New Era. The seed-coat color is neither one of the parental patterns and may be taken as the result of varietal hybridity.

SUMMARY OF CONCLUSIONS

This paper deals with the mode of inheritance of certain characters in the cowpea, *Vigna sinensis* Endl., and with the yield and culinary quality of the varietal hybrid produced. The experimental results may be summarized as follows:

1. The White Paayap, a native Philippine variety of cowpea, is a hardy plant, a favorite legume vegetable, and produces white flowers and white seeds. The New Era, an introduced variety, is a prolific plant and produces pale purple flowers and grayish blue or blue seeds. It is not as well liked as a vegetable as the White Paayap.

2. In crosses between these two varieties of cowpea, the inheritance of characters was as follows:

(*a*) Flower color is unifactorial in heredity. A cross between purple and white gave purple in F_1 and 3 purple : 1 white in F_2.

(*b*) Seed-coat color is bifactorial in heredity. A cross between blue and white gave blue in F_1 and segregated into 9 blue : 3 brown : 4 white in F_2.

(*c*) Pod color is unifactorial in heredity. The evidence was derived from a segregation of 3 black: 1 white, which was to be expected from a selfed heterozygote and from a segregation of 1 black : 1 white, which should result from a back cross of heterozygous dominant to a homozygous recessive.

(*d*) Linkage relations. It was shown that the genes for white seeds and white flowers and those of colored seeds and purple flowers were closely linked. The genes for pod color and seed color were suspected to be loosely linked. Other cases of linked characters showing repulsion have been reported.

3. The yields of F_1 and F_2 populations and the parental varieties were compared on the basis of mean, range, and Weinberg's measure of variability.

(*a*) The Hybrid Brown segregate proved a slightly better yielder than the White Paayap and ranks equal to the New Era parent.

(*b*) The Hybrid Brown cowpea selected from the hybrid population is as hardy as the White Paayap and as prolific as the New Era. The new cowpea merits testing with other cowpea varieties.

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ILLUSTRATION

PLATE 1

FIG. 1. Showing the inheritance of flower color in a cross between New Era and White Paayap cowpeas.

2. Showing the segregation of seed color in a cross between White Paayap and New Era. *a,* White Paayap (native); *b,* Hybrid Brown (new cowpea); *c,* New Era (introduced).

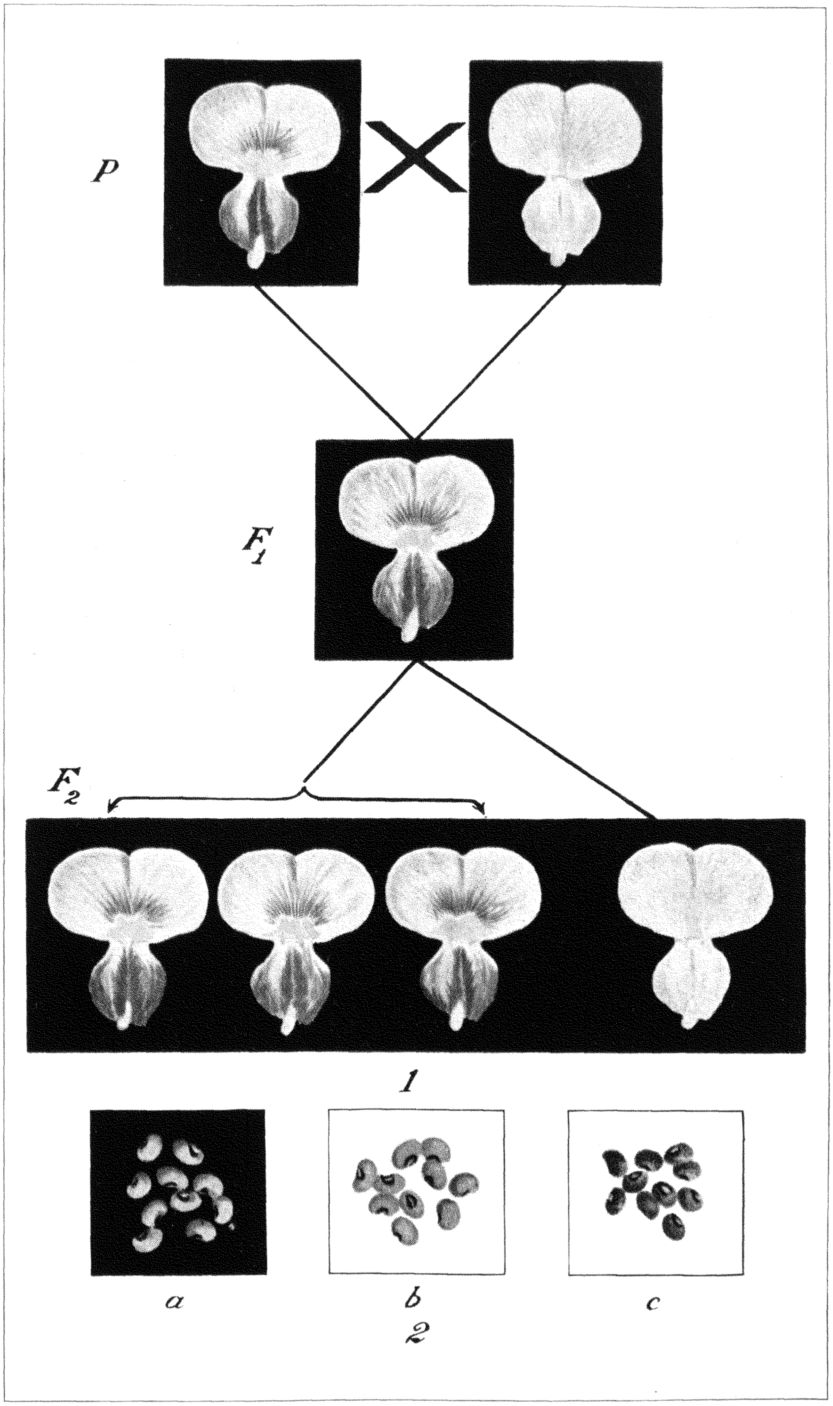

PLATE 1.

NOTES ON PHILIPPINE MOSQUITOES, III

GENUS CULEX: GROUPS LOPHOCERATOMYIA, MOCHTHOGENES, AND NEOCULEX [1]

By F. E. Baisas

Of the Philippine Health Service, Manila

FOUR PLATES AND TWO TEXT FIGURES

Many of the species belonging to these groups are new, indicating that probably intensive collecting will bring to light other new forms.

Particular care has been exercised in the preparation of male terminalia for drawings. The phallosomes were drawn in their natural position; no cover glass was used to avoid distortion of shapes and natural arrangement of parts. When pressed or tilted a specimen will vary greatly from its natural appearance. It is sometimes difficult to keep a specimen in the desired position even when manipulated in thick mounting fluids; in such a case small pieces of broken cover glass used as supports will keep the organ at any angle wanted.

No species so far known of the Philippine *Lophoceratomyia* group possesses a true matted tuft on segment 9 of the male antenna, the scales forming the tuft being separated from one another from base to tip when examined in slide preparation.

The conclusions arrived at in naming as new those species which closely resemble forms found in other countries are the

[1] Submitted for publication February, 1935. Performed in the central laboratory of the malaria section, Philippine Health Service, Manila, of which Dr. Antonio Ejercito is chief. Grateful acknowledgments are here reiterated to Dr. Ejercito for his generosity and helpfulness; to Dr. Paul F. Russell, of the Rockefeller Foundation, who does not cease to be a source of help by correspondence and sending of materials from India where he is at present stationed; to Director Angel Argüelles, of the Bureau of Science, for extending to me the free services of the photographic division of his bureau; and to Mr. Domingo Santiago, of the School of Hygiene and Public Health, University of the Philippines, for lending me some of his specimens. To Mr. W. Garcia, artist of the malaria section, Bureau of Health, belongs the credit of inking all the drawings.

result of careful comparison of the specimens on hand with the descriptions and illustrations, particularly of the male terminalia, as given by various authorities. An attempt has been made to show as faithfully as possible the details of the male terminalia in our drawings.

The terms used in designating parts are adapted from those employed by Christophers and Barraud (1933–1934). Text figs. 1 and 2 show the more important parts of the male terminalia.

CULEX (LOPHOCERATOMYIA) MINDANAOENSIS sp. nov.

Type.—Male (lot M–x).

Cotype.—Male (lot M–y). Type and cotype are both in the collections of the Bureau of Health, Manila.

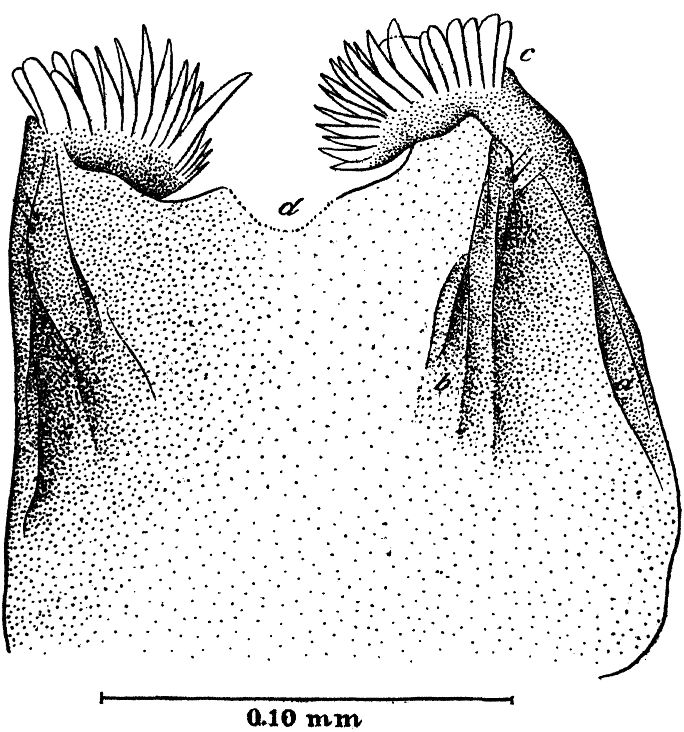

FIG. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., proctiger (anal segment), tergal view; *a*, paraproct; *b*, dorsal plate of proctiger (tergite X); *c*, crown of paraproct; *d*, anus.

Type locality.—Cotabato, Cotabato Province, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—July 5, 1934.

Habits.—Larva breeds in fresh-water swamps; habits of adults unknown.

Distribution.—Known only from the type locality.

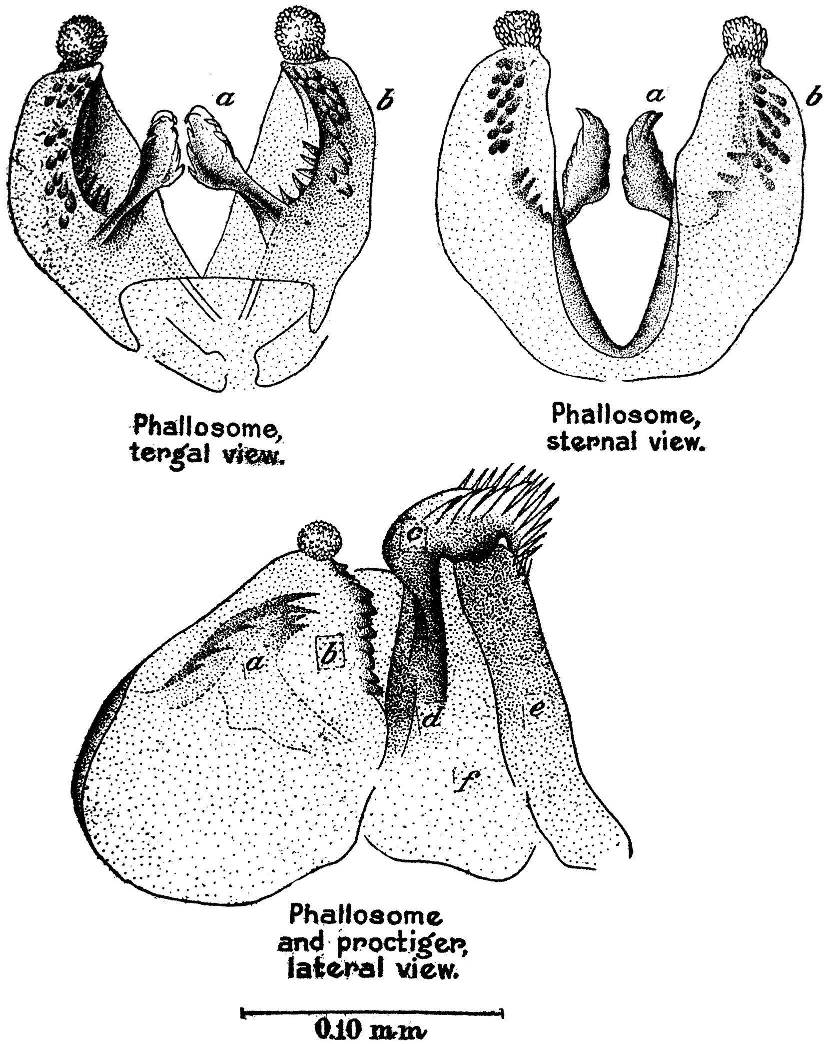

FIG. 2. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp nov., phallosome and proctiger; *a*, median process of phallosome; *b*, lateral process of phallosome; *c*, crown of paraproct; *d*, paraproct; *e*, dorsal plate of proctiger (tergite X); *f*, proctiger (anal segment).

Adult (*male*).—Head clothed with narrow, brown scales mixed with upright, forked ones on vertex and nape, except along eye margins where pale, broad scales are present. A patch of pale broad scales on either side to border of eyes. Proboscis a little

longer than front femur, dark brown. Palpi exceed the proboscis by more than half the length of the ultimate segment; the last two segments with very few hairs. Torus of antenna with a prominence; a few narrow scales of about equal length on segment 6; twisted and crumpled scales on 7 to 9, with a row of short straight scales on 8 and 9; a few somewhat thickened hairs on 10. Thorax with integument of mesonotum dark brown; scales narrow, brown; bristles darker. Scutellar scales narrow, brown. Postnotum and pleura pale brown. Wings dark-scaled.[2] Abdomen dark brown dorsally, paler ventrally. Legs mostly dark-scaled, undersides of femora pale; a portion of the basal dorsal surface of hind femora also pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a narrow leaf, one long bristle which is curved apically, one fairly long and three short curved blades, three still longer blades two of which are hooked at tips, the third twisted at apex. A row of about four slightly curved hairs on dorsal border of coxite. Phallosome with the lateral process much larger than the median process, possesses a bunch of short, blunt teeth forming a crown at apex; a few prominent, and some short, blunt teeth along its tergal border. The median process has prominent teeth projecting upwards when viewed from the tergal side. Paraproct with a crown of teeth, but having no basal arm (text figs. 1 and 2).

CULEX (LOPHOCERATOMYIA) NOLLEDOI sp. nov.

Type.—Male (lot R112–ax), and female (lot R112–ay).

Cotypes.—Seven males and 7 females. Types and cotypes are in the collection of the Bureau of Health, Manila.

Type locality.—Kolambugan, Lanao Province, Mindanao.

Collector.—Francisco Guinto.

Date of collection.—July 31, 1934.

Habits.—Larva breeds in rock holes in forest creeks; habits of adults unknown.

Distribution.—Known also from Limay, Bataan Province, Luzon (*United States Army Medical Department Research Board*).

Adult (*male and female*).—Separable from *mindanaoensis* only by means of male terminalia. Head with vertex and nape, excepting along eye margins, clothed with narrow, brown, flat,

[2] The relation of *af* to its petiole varies much among different individuals within a species and is of no practical value in identifying the members of the groups.

and upright, forked, dark scales; a row of pale, broad scales along eye margins broadening at sides. Proboscis a little longer than front femur. Palpi of female about one-sixth the length of proboscis; palpi of male exceeding the proboscis by about one-half the length of the ultimate segment, the last two segments having a few hairs. Torus of male antenna with a prominence; some narrow scales (hairlike in some individuals) of about equal lengths on segment 6; twisted scales on 7 to 9, with a row of short, straight ones on 8 and 9; a few short thickened hairs on 10. Thorax with integument of mesonotum dark brown, bristles also dark brown, scales paler. Scutellar scales narrow, brown. Postnotum and pleura brown. Wings dark-scaled. Legs mostly dark; about basal half of hind femur and undersides of all femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three long curved blades, two of which are hooked at tips; three shorter curved blades, one spine curved at apex, and a narrow leaf. A row of six to eight long recurved hairs on dorsal border of coxite. Lateral process of phallosome with a crown of short blunt teeth at apex; some coarser teeth on its tergal border. Median process longer than that of *mindanaoensis*, but having no definite teeth.

CULEX (LOPHOCERATOMYIA) PACHECOI sp. nov.

Types.—Male (lot F150–7) and female (lot F150–5), with their larval skins.

Cotypes.—Five females with larval skins; 5 males and 7 females without larval skins.

Isotypes.—Four males and 3 females.

Type locality.—College of Agriculture, Los Baños, Laguna Province, Luzon.

Collector.—F. E. Baisas.

Date of collection.—February 2, 1935.

Habits.—Larva breeds in semistagnant edges of forest creeks; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Externally very similar to *fraudatrix* and *josephineæ* (described below), from which it differs in the presence of two broad leaves on the subapical lobe of coxite of male terminalia. Head with vertex and nape, except along eye margins, covered with numerous upright, forked, dark scales, mixed with less numerous narrow, flat, brown ones. A row of pale, broad, flat scales along eye margins, broadening

at sides. Proboscis slightly longer than front femur, more than six times the length of female palpi, but exceeded by male palpi by more than the length of the last segment. Last two segments of male palpi with many hairs. A transverse row of stiff bristles at base of male proboscis underneath. A fingerlike process at base of each male palp. Torus of male antenna without a prominence; three or four long sharp-pointed scales on segment 6; twisted blades on 7 to 9, with two particularly broad but short ones on 8; about three long blades, abruptly tapering to a point near apices on 10; and about three thick hairs on 11. Thorax with scales and bristles of mesonotum dark brown. Scutellar scales narrow, brown; bristles darker. Postnotum brown, pleura much paler. Wings dark-scaled. Abdominal tergites dark, sternites less so. Legs mostly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with two broad leaves, three long curved blades, two of which are hooked at tips; three shorter blades, and one spine. A row of five or six hairs on dorsal border of coxite. Style gradually tapering towards apex. Phallosome with lateral process [3] a roughly conical, hollow structure bent towards apex; partly divided into two apically; no teeth.

CULEX (LOPHOCERATOMYIA) JOSEPHINEÆ sp. nov.

Types.—Male (lot R35–x) and female (lot R35), both of which are in the collection of the Bureau of Health, Manila.

Type locality.—Del Carmen, Pampanga Province, Luzon.

Collector.—F. E. Baisas.

Date of collection.—March 6, 1930.

Habits.—Larva breeds in a clear, vegetated river slew; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Very closely resembles *fraudatrix* but differs in male terminalia. Head with narrow, flat, brown scales confined to nape; upright, forked, dark scales more widely distributed. A line of pale, broad, flat scales along eye margins broadening at sides. Proboscis distinctly longer than front femur. Palpi of female less than one-sixth the length of proboscis; palpi of male longer than the proboscis by about one and one-half

[3] In *pachecoi*, *josephineæ*, and *fraudatrix* what is called the lateral process may seem to correspond to the median process of *mindanaoensis*, *nolledoi*, and *mammilifer*, but since this is the only structure arising from the basal plate, the term lateral process is considered applicable.

times the length of ultimate segment; the last two segments of male palpi with many hairs. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; a tuft of long scales on segment 6; crumpled scales on segments 7 to 9; about three long scales, which broaden a little toward the apices, but ending in sharp points, on 10. Thorax with integument of mesonotum together with mesonotal scales and bristles dark brown. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites and sternites dark. Legs mostly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a fairly large leaf, aside from the usual blades and bristle. A row of about four weak hairs on dorsal border of coxite. Style gradually tapers toward apex. Phallosome with lateral process bent tergolaterally towards apex; partly divided into three distally; a few knobs and a distinct branchlike projection at lower bend. Small sharp teeth on the sternal border basally. No median process.

CULEX (LOPHOCERATOMYIA) FRAUDATRIX Theobald (1905).

Habits.—Larva breeds in impounded, clear, vegetated spring water, and slow-flowing vegetated streams; habits of adults unknown.

Distribution.—Known only in Calauan, Laguna Province, Luzon (*D. Santiago*).

Adult (*male and female*).—(From specimens lent to me by Mr. D. Santiago.) Head with vertex and nape clothed with flat, narrow, dark brown scales and upright, forked, dark scales. A line of broad pale scales along eye margins broadening at sides. Proboscis a little longer than front femur; a transverse row of stiff bristles at base underneath. Palpi of female about one-sixth the length of proboscis, of male longer than proboscis by about the length of ultimate segment; the last two segments of male palpi with many hairs. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; about four short hairs on each of segments 2 to 5; a tuft of long scales on 6; twisted blades on 7 to 9; about three blades on 10, and some thickened hairs on 11. Thorax with mesonotal integument, scales, and bristles dark brown. Pleura dark brown. Wings dark-scaled. Abdominal tergites dark, sternites paler. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a fairly large leaf; three long, curved, and several shorter

blades. A row of about four or five weak hairs on dorsal border of coxite. Style broadens distinctly towards apex. Phallosome with lateral process partly divided into two apically; roughly conical in shape, and bent towards apex; no teeth.

CULEX (LOPHOCERATOMYIA) INFANTULUS Edwards (1922).

Habits.—Larva breeds in vegetated, slow-flowing streams; habits of adults unknown.

Distribution.—Tungcong Manga, San Jose, Bulacan Province, Luzon (*Baisas*); known also from Calauan, Laguna Province, Luzon (*D. Santiago*).

Adult (*male and female*).—Resembles *minutissimus* very closely, but differs in male genitalic characters. Head with vertex and nape clothed with narrow, flat, pale brown, and upright, forked, dark scales; a border of broad, flat, pale scales along eye margins broadening at sides. Proboscis distinctly longer than front femur. Palpi of female about one-sixth the length of proboscis; of male longer than proboscis by about half the length of ultimate segment, the last two segments scantily haired. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; two short scales on segment 8; about four longer scales on 9. Thorax with mesonotal integument and scales pale brown, bristles darker. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites dark brown with pale basal bands; sternites brown. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite, without the usual broad leaf, with three fairly long blades curved at apices, and several shorter blades and spines. A row of short, widely separated hairs on dorsal border of coxite. Style tapering towards apex. Phallosome with lateral process a curved, hollow, conical cylinder, the sides roughly simulating a beehive. Basal process a simple plate.

CULEX (LOPHOCERATOMYIA) MAMMILIFER Leicester (1908).

Habits.—Larva breeds in forest creek; habits of adults unknown.

Distribution.—College of Agriculture, Los Baños, Laguna Province, Luzon (*Baisas*), and Iwahig, Palawan (*Baisas*).

Adult (*male*).—Head with vertex and nape covered with pale, brown, narrow, flat, and upright, forked, dark scales. A line of pale, broad, flat scales along eye margins broadening at sides. Proboscis longer than front femur. Palpi exceed the proboscis

by the length of ultimate segment, the last two segments scantily haired. Torus of antenna with prominence; some large scales of progressively increasing lengths on segment 6; crumpled scales mixed with short straight ones on 7 to 9; some short, thickened hairs on 10. Thorax with integument, scales, and bristles of mesonotum dark brown. Wings dark-scaled. Abdomen dark dorsally and ventrally. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three long, curved blades, two of which are hooked at tips, one narrow leaf, one fairly straight blade, and three short spines. A row of six or seven strong, curved hairs on dorsal border of coxite. Style with a crest of short hairs near apex. Phallosome with lateral process having a crown of short blunt teeth at apex. A row of larger teeth along its tergal border. Median process fairly long, but without definite teeth.

CULEX (MOCHTHOGENES) YEAGERI sp. nov.

Type.—Male (lot R66–xyz).

Cotypes.—Three males. Type and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Iwahig, Palawan.

Collector.—F. E. Baisas.

Date of collection.—June 7, 1934.

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male*).—Head with narrow, flat, pale brown scales confined to nape; upright, forked, dark scales scattered on vertex and nape; broad, flat, pale scales cover vertex and sides. Proboscis distinctly longer than front femur. Palpi less than one-sixth the length of proboscis. Thorax with mesonotal integument and scales pale brown. Wings dark-scaled. Abdominal tergites dark brown with narrow, pale, apical rings; sternites dark brown, the posterior ones with pale apical patches in continuation of the tergal rings. Legs mainly dark brown, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a broad leaf, several narrow blades, and spines. Style broad, short, forked. Phallosome with lateral process having a few short blunt teeth along the internal tergal border. No median process.

CULEX (MOCHTHOGENES) CHIYUTOI sp. nov.

Types.—Male (lot R33–xxz) and female (lot R33–xyz).

Cotypes.—Five males. Types and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Kolambugan, Lanao Province, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—March 28, 1934.

Habits.—Larva breeds in tree holes; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Head with vertex and nape covered with narrow, pale brown, flat, and upright, dark and brown, forked scales; a patch of pale broad scales on sides to border of eyes. Proboscis much longer than front femur; palpi of both sexes about one-sixth the length of proboscis. Thorax with integument of mesonotum dark brown; scales narrow, brown; bristles numerous, strong, dark. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites dark, sternites a little paler. Legs mainly dark-scaled; hind femora of female entirely white underneath, dorsal surface white also from base to about middle of segment; undersides of all other femora also pale. Hind femora of male not so extensively pale dorsally as that of the female.

Male terminalia (*see illustration*).—Subapical lobe of coxite with two curved leaves, one of which is like a boat; a narrow curved blade and five smaller boatlike leaflets. Style simple. Phallosome with lateral process having a number of teeth on tergal border. No median process.

CULEX (MOCHTHOGENES) LAURELI sp. nov.

Type.—Male (lot R38–xx); in the collection of the Bureau of Health, Manila.

Type locality.—Malaybalay, Bukidnon Province, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—April 4, 1934.

Habits.—Larva breeds along the vegetated edges of rapidly flowing streams; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male*).—Head with vertex and nape clothed with narrow, pale, flat, and upright, forked, dark scales. A line of pale, broad, flat scales on border of eyes broadening at sides. Proboscis longer than front femur. Palpi less than one-sixth the length of proboscis. Thorax with mesonotal integument and scales

brown; bristles not strong, dark brown. Wings dark-scaled. Abdominal tergites dark; sternites a little paler. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three leaflets, one of which has strong serrations on one side; three fairly long curved blades, the broadest having flaps at tip; and a short spine. Style fairly long, forked. Phallosome with lateral process having some teeth along the tergal border. No median process.

CULEX (NEOCULEX) BREVIPALPIS Giles (1902).

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Known only from Limay, Bataan Province, Luzon (*United States Army Medical Department Research Board*).

Adult (*male and female*).—Head with vertex and nape clothed with narrow, pale, flat, and numerous yellowish, upright, forked scales. A patch of pale broad scales on either side. Proboscis longer than front femur. Palpi of female less than one-sixth the length of proboscis; of male about two-thirds the length of proboscis. Thorax with mesonotal integument and scales brown to dark brown; bristles numerous, dark, the majority aligned in two rows near the middle from anterior to posterior margins of mesonotum; others are grouped above wing roots. Scutellar scales narrow, dark brown. Pleura pale brown with indefinite pale patches. Wings dark-scaled. Abdominal tergites dark brown; sternites paler, particularly the terminal ones. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a leaf, three long and three short blades curved at tips. Phallosome divided into two broadly conical lobes each having some blunt teeth on apical, internal, tergal border.

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ILLUSTRATIONS

PLATE 1. MALE TERMINALIA

FIG. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov.; *a*, sternal view.
2. *Culex* (*Lophoceratomyia*) *nolledoi* sp. nov.; *a*, sternal view.
3. *Culex* (*Lophoceratomyia*) *pachecoi* sp. nov.; *a*, sternal view.

PLATE 2. MALE TERMINALIA

FIG. 1. *Culex* (*Lophoceratomyia*) *frandatrix* Theobald; *a*, sternal view; *b*, lateral view.
2. *Culex* (*Lophoceratomyia*) *josephineæ* sp. nov.
3. *Culex* (*Lophoceratomyia*) *mammilifer* Leicester.

PLATE 3. MALE TERMINALIA AND MALE ANTENNÆ

FIGS. 1 and 2. *Culex* (*Neoculex*) *brevipalpis* Giles.
3 to 5. *Culex* (*Lophoceratomyia*) *infantulus* Edwards.
FIG. 6. *Culex* (*Lophoceratomyia*) *pachecoi* sp. nov.
7. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov.
8. *Culex* (*Lophoceratomyia*) *mammilifer* Leicester.
9. *Culex* (*Lophoceratomyia*) *josephineæ* sp. nov.
10. *Culex* (*Lophoceratomyia*) *nolledoi* sp. nov.
11. *Culex* (*Lophoceratomyia*) *fraudatrix* Theobald.

PLATE 4. MALE TERMINALIA

FIG. 1. *Culex* (*Mochthogenes*) *chiyutoi* sp. nov.; *a*, sternal view; *b*, lateral view.
2. *Culex* (*Mochthogenes*) *yeageri* sp. nov.
3. *Culex* (*Mochthogenes*) *laureli* sp. nov.

TEXT FIGURES

FIG. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., proctiger (anal segment), tergal view.
a, Paraproct.
b, Dorsal plate of proctiger (tergite X).
c, Crown of paraproct.
d, Anus.

2. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., phallosome and proctiger.
a, Median process of phallosome.
b, Lateral process of phallosome.
c, Crown of paraproct.
d, Paraproct.
e, Dorsal plate of proctiger (tergite X).
f, Proctiger (anal segment).

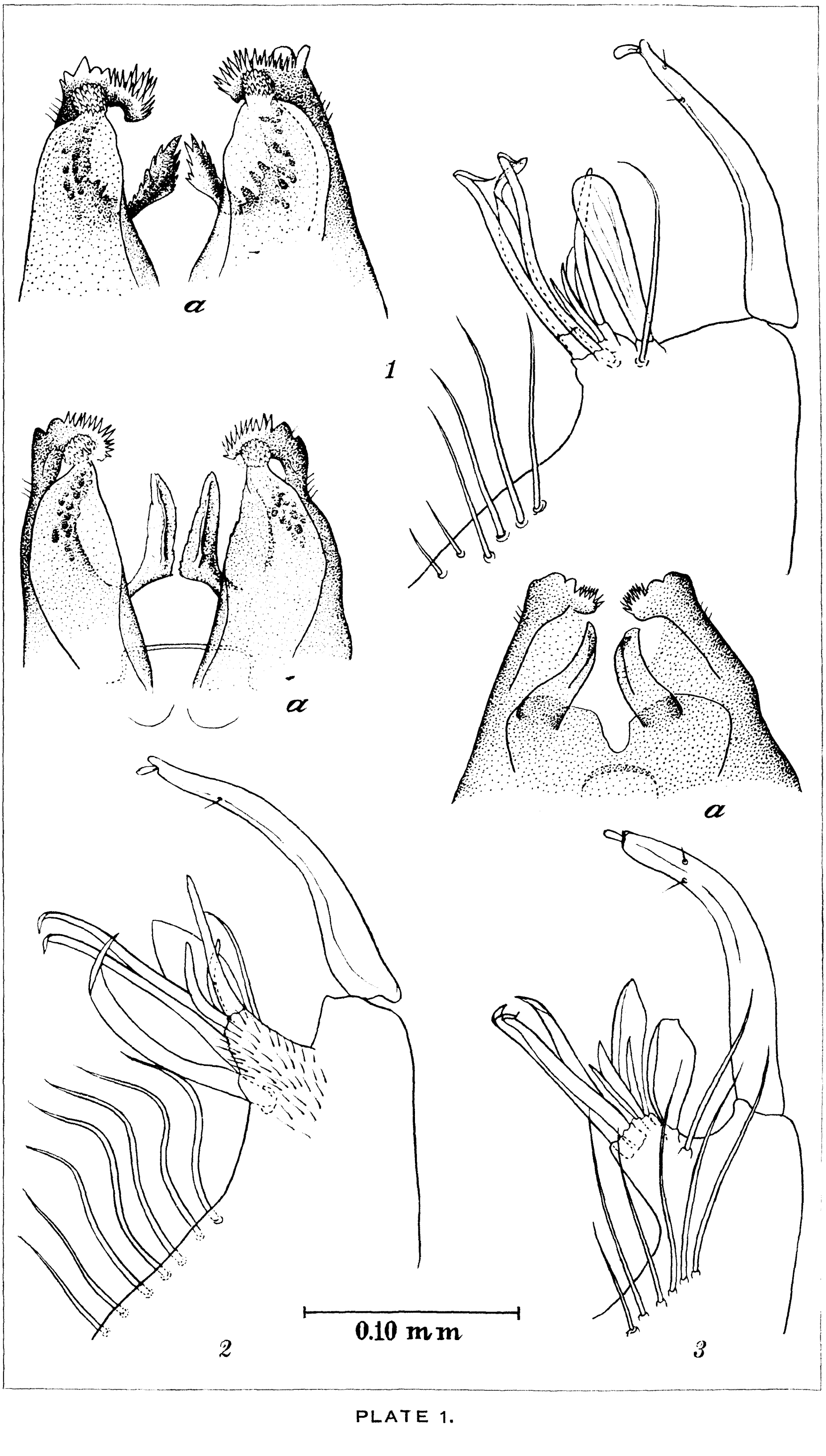

PLATE 1.

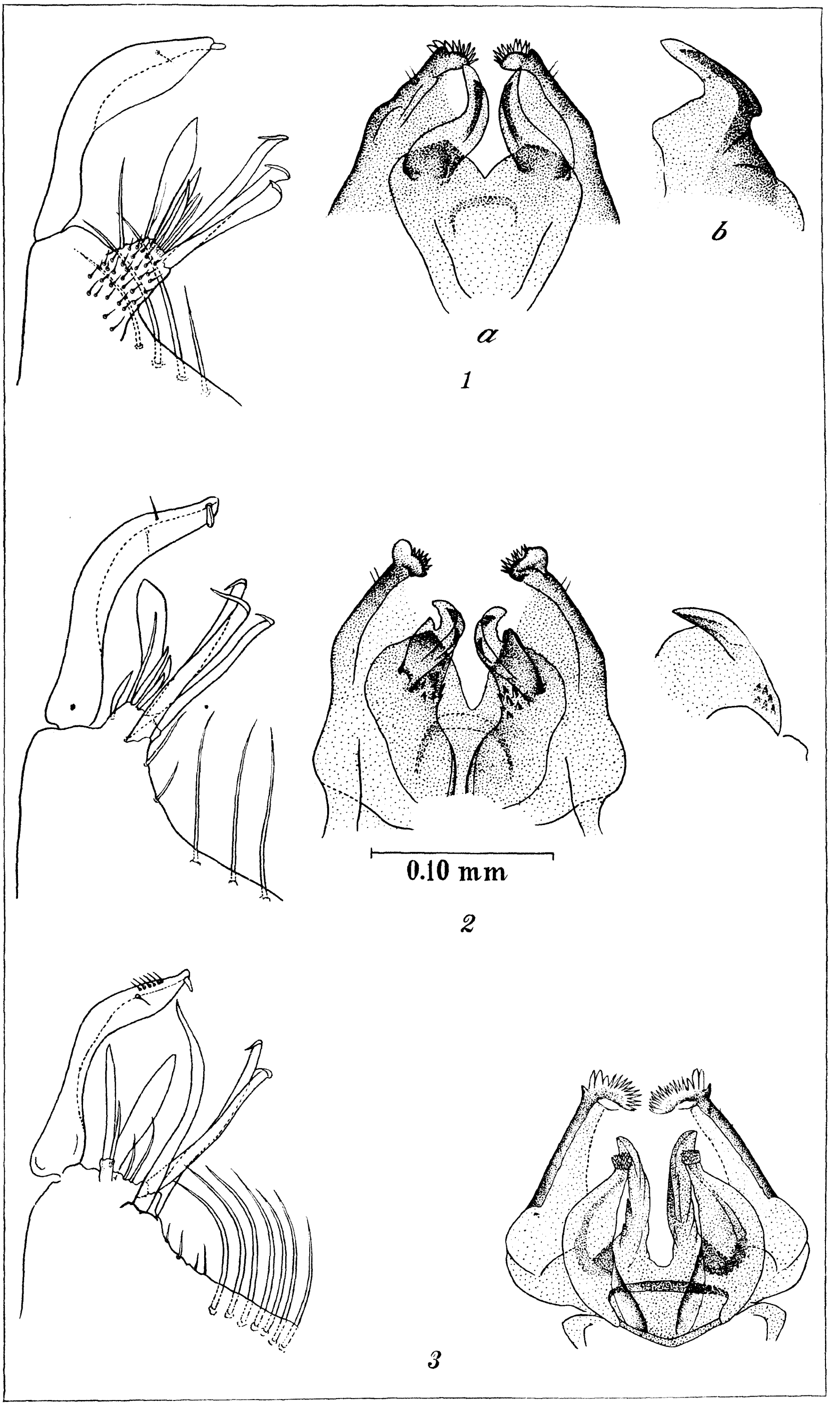

PLATE 2.

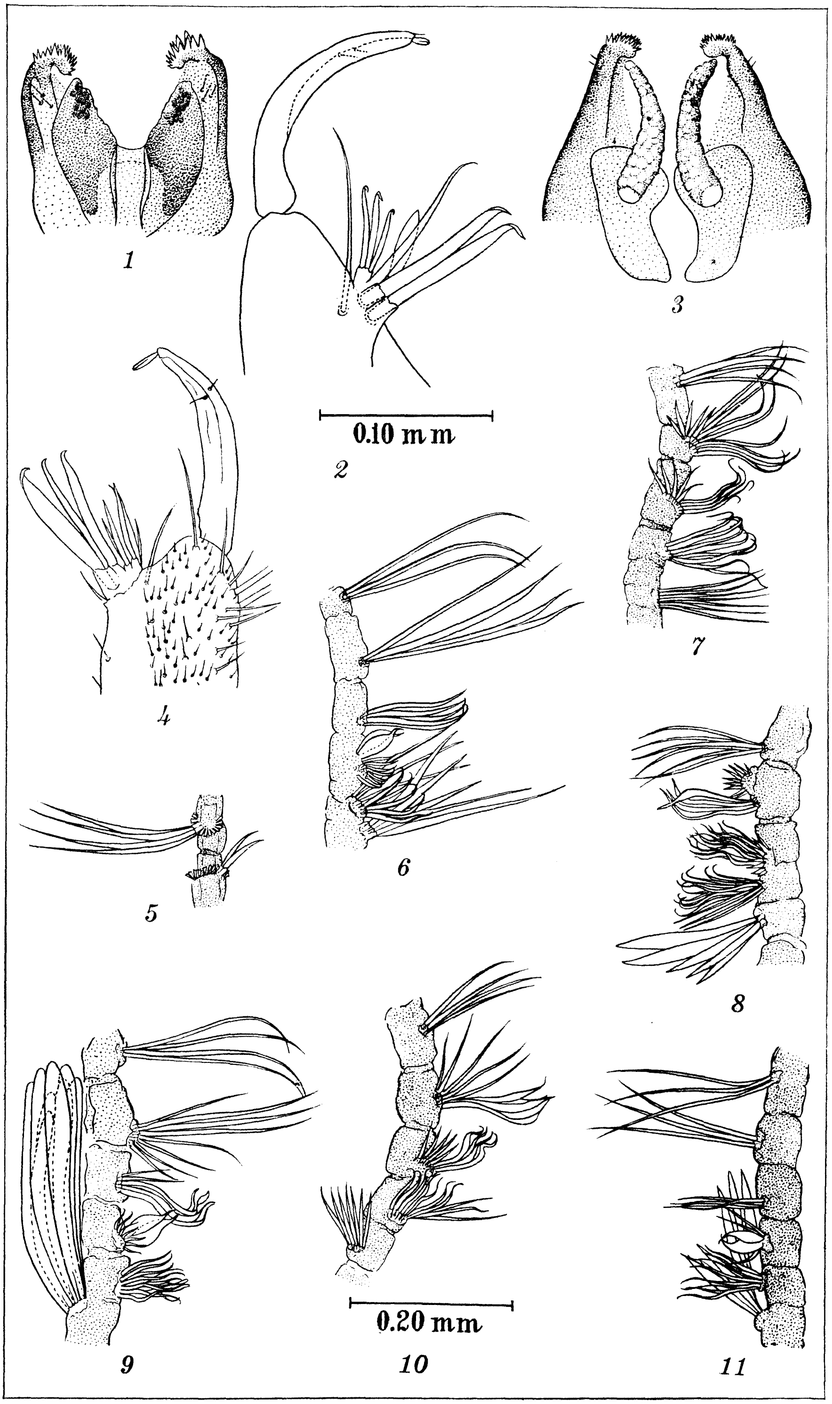

PLATE 3.

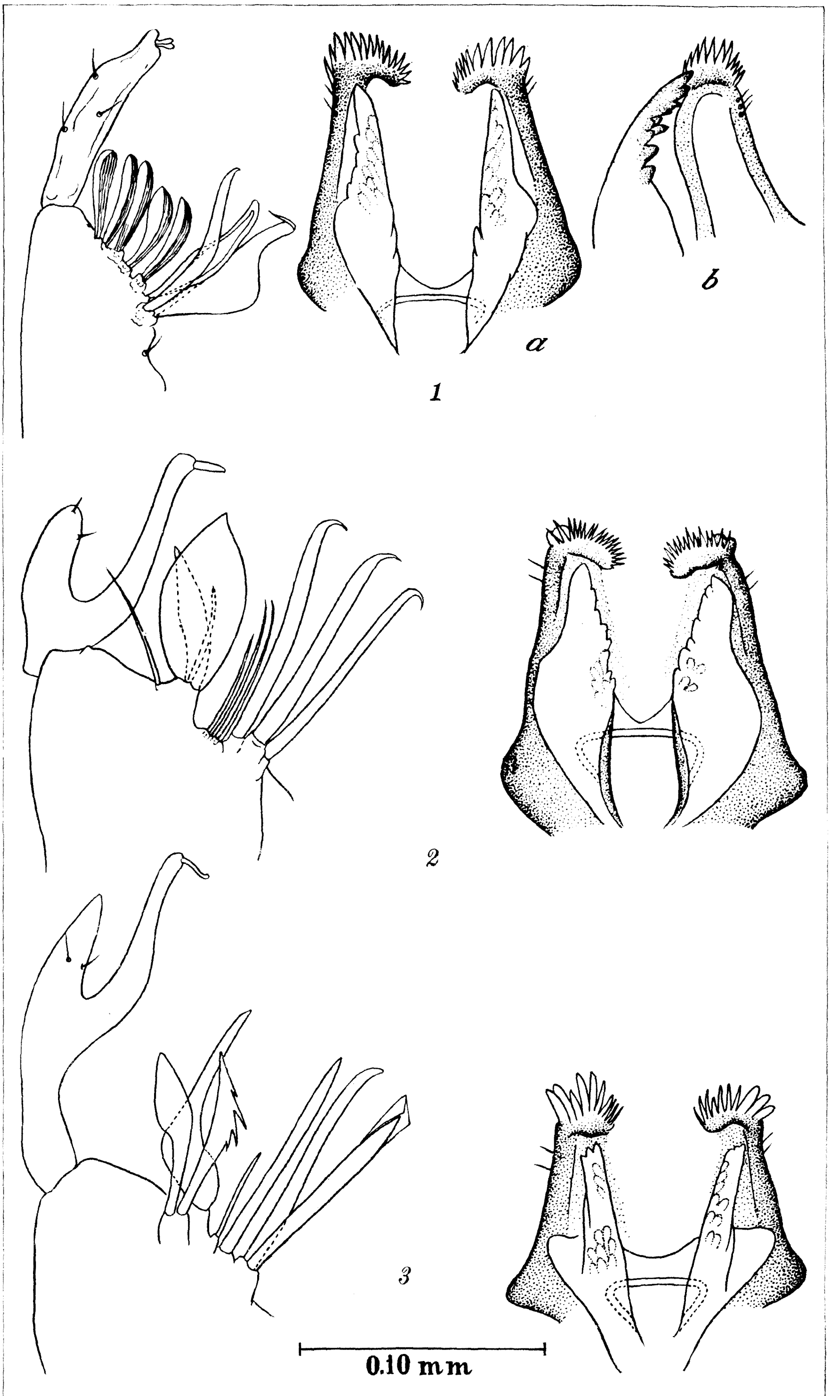

PLATE 4.

NEW SPECIES AND RECORDS OF LONGICORNS FROM FORMOSA (COLEOPTERA: CERAMBYCIDÆ)

By J. LINSLEY GRESSITT

Of the University of California, Berkeley

The following descriptions of new species, synonymical notes, and new records are based primarily on material collected by the author during two trips to Formosa in 1932 and 1934, respectively. Previous contributions to the cerambycid fauna of Formosa, as well as Japan and the Loochoo Islands, were made by the author.[1] The author wishes to express his appreciation to Dr. E. C. Van Dyke, of the University of California, for his suggestions in the course of the preparation of the paper.

CERAMBYCINÆ

DISTENIINI

Genus NOEMIA Pascoe

NOEMIA INCOMPTA Gressitt sp. nov.

Extremely narrow, parallel-sided; dark grayish brown, nearly black; bases of legs pale; sparsely, but almost entirely, clothed with moderately short, suberect setæ; antennæ furnished with a row of long, equal, fine hairs on the inner side, which are not always visible.

Head directed anteriorly, constricted anterior to antennal insertions; maxillary palpi large, last segment fusiform; frons broad, concave, only slightly oblique to dorsal surface; eyes reniform, moderate-sized, posterior to insertions of antennæ, subemarginate anteriorly; vertex slightly concave in middle, but swollen at sides next to antennal supports, which are low; vertex and occiput minutely punctulate; ventral surface reddish brown, subglabrous. Antennæ (female?) one and three-fourths times as long as body, very fine, filiform; scape pedunculate, long, basal third narrow and curved, remaining portion swollen and fusiform; second segment shorter than broad; the remaining segments hardly appreciably diminishing in length or thickness;

[1] Pan-Pacific Entomol. 9: 163–170; Philip. Journ. Sci. 55 (1934) 379–386.

third to fifth segments very slightly thickened at extreme apices; clothed with a few very short hairs, and furnished internally with a row of long thin hairs which are generally hidden or lost. Prothorax nearly twice as long as broad at base, apex slightly narrower than base, constricted near base and apex, central portion hardly rounded above, furnished at each side with a broad-based tubercle with blunt apex; surface with dense, microscopic puncturation and also with a few, scattered, shallow punctures of larger size. Scutellum small, as long as broad, rounded posteriorly. Elytra long, narrow, subparallel, only slightly narrowed posteriorly; furnished with close, deep puncturations, arranged in about ten irregular longitudinal rows, the rows divided by a few rather indistinct longitudinal ridges; apices slightly narrowed and rounded. Ventral surface sparsely punctate; coxæ and thoracic sutures amber-colored; first three abdominal segments subequal, diminishing slightly in length, fourth segment slightly shorter than fifth, which is slightly less than third. Legs relatively short, nearly black, the bases of femora testaceous; clothed with irregular light hairs; femora pedunculate and fusiform, anterior pair most swollen; tibiæ moderately straight; tarsi very short, first segment of fore and middle pairs slightly shorter than second and third segments combined, equal in the hind tarsi, last segment short.

Length, 11.25 millimeters; breadth, 1.8.

Holotype, probably a female, No. 50899, United States National Museum, taken by the author at Hassenzan, north-central Formosa, altitude 1,500 meters, June 25, 1934; and one paratype, of the same sex, taken by the author near Hori, central Formosa, altitude 600 meters, June 9, 1934, in the author's collection.

This species agrees fairly well in characters with the genus to which it is referred, which is centered in Madagascar but also has some species in the Indo-Malayan and Philippine subregions.

OEMINI

Genus OPLATOCERA White

OPLATOCERA OBERTHURI Gahan.

Oplatocera oberthuri GAHAN, Fauna Brit. Ind. 1 Ceramb. (1906) 108, fig. 43.

Female.—Large, sides subparallel, antennæ fine; light brown marked with darker brown and black; pronotum with two short

oblique oval black spots on center of disc which touch anteriorly, and a narrow black line along side just above lateral tubercle; elytra marked with two, interrupted, strongly oblique bands of dark brown, the first placed before the middle, consisting of two spots, the one narrow and long, beginning near the external margin and continuing to near middle, and the other obliquely oval, sublongitudinal, on disc away from suture, the second band more complete, its margin irregular, commencing near external margin behind the middle and extending into the last quarter to slightly nearer the suture than the first band; palpi, eyes, apices of antennal segments, particularly the first five or six, bases of trochanters and apices of coxæ, femora and tibiæ black; body except elytra and abdomen clothed with very short suberect golden hairs, longer on underside of antennæ, and blacker on head and prothorax, the latter with a somewhat silvery pubescent effect, elytra with the finest and most obscure white pubescence.

Head nearly as broad as long, concave between the eyes, granulose; frons, clypeus, and labrum very short; mandibles small; eyes oblique, deeply constricted, ventral lobe globular, dorsal lobe broadly oval. Antennæ one-fourth longer than body; rather fine, the first five or six segments thickened, funnel-shaped at apices, third to fifth segments finely toothed externally; scape cone-shaped, broadest at extreme apex, produced slightly externally; second segment barely broader than long; third segment twice as long as scape, one-fourth longer than fourth segment, fourth and succeeding segments diminishing evenly in length, the apical three subequal. Prothorax broader than long, acutely tuberculate at sides, deeply constricted near base, narrowly near apical margin; surface granulose. Scutellum small, triangular. Elytra together two and one-half times as long as broad, subparallel, slightly narrowed posteriorly; margins concave before middle; surface marked with four longitudinal costæ, the inner two commencing at base and uniting before apical quarter, the outer two arising behind shoulder, the fourth disappearing posteriorly and the third converging with the second near apex; apices narrowed, with the sutural angles nearly acute. Legs moderate, with the femora short; first segment of hind tarsi barely as long as following two segments united; claws small.

Male.—Elytra strongly narrowed posteriorly, apical margin black; prothorax larger, hardly constricted before lateral tubercles.

Length, female, 37 millimeters, male, 30; breadth, female, 10, male, 9.

A female taken by the author at Hassenzan, Formosa, altitude 1,250 meters, June 27, 1934; a male (antennæ missing) taken near Bukai, central Formosa, altitude 900 meters, June 14, 1934.

Habitat.—India (Sikkim, Darjeeling, British Bhutan); China (Szechwan Province); Formosa (central part).

Identical with a specimen in the collection of the California Academy of Sciences from Szechwan, China, compared with the type in the British Museum by E. C. Van Dyke. Hitherto unrecorded from China or Formosa.

CERAMBYCINI

Genus HEMADIUS Fairmaire

HEMADIUS OENOCHROUS Fairmaire.

Hemadius oenochrous FAIRM., Ann. Soc. Ent. France VI 9 (1889) 57 (Ngan-Hoei, China).

Neocerambyx stötzneri HELLER, Ent. Blätter 19 (1923) fig. 72 (China); PLAVILSTSHIKOV, Koleopt. Rund. 17 (1931) 195 (=*H. oenochrous*).

Neocerambyx mushaensis KANO, Trans. Nat. Hist. Soc. Formosa 18 (1928) 224 (Musha, Formosa).

A handsome, large species; glossy black, clothed above with dense, silky pubescence of a bright red color; dorsal surface of tarsi and latter half of antennæ silvery.

Habitat.—China (Tibet to Fukien Province); Formosa (Musha, Hori, Taiheizan, Rahau, and Hinokiyama).

Genus PSEUDAEOLESTHES Plavilstshikov

Pseudaeolesthes PLAVILS., Bestim.-Tabell. europ. Coleopt. 100 (1931) 73. Genotype: *Aeolesthes chrysothrix* (Bates).

Niphocerambyx MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ., Sapporo 34 (1933) 244. Genotype: *Aeolesthes chrysothrix* (Bates).

PSEUDAEOLESTHES CHRYSOTHRIX (Bates).

Neocerambyx chrysothrix BATES, Ann. & Mag. Nat. Hist. IV 12 (1873) 152, female (Nagasaki, Japan); Linn. Journ. Zool. 18 (1884) 208, male (Tokyo).

Neocerambyx batesi HAROLD, Abhandl. Nat. Ver. Bremen 4 (1875) 295, male (Japan); LEWIS, Entomologist 26 (1893) 152 (=*chrysothrix* Bates).

Aeolesthes chrysothrix (Bates) AURIVILLIUS, Col. Cat. Ceramb. pars 39 (1912) 47.

Pseudaeolesthes chrysothrix (Bates) PLAVILS., Bestim.-Tabell. europ. Coleopt. 100 (1931) 73.

Niphocerambyx chrysothrix (Bates) MATSUSH., Journ. Fac. Agr. Hokkaido Imp. Univ., Sapporo 34 (1933) 244.

A narrow, elongate species; the elytra somewhat sculptured and clothed with a dense, golden or golden brown pubescence lying in different directions, which gives a strikingly variable appearance; antennæ of female slightly longer than body, those of male nearly two and one-half times length of body; prothorax subacutely tuberculate at sides; elytral apices subobliquely truncate and bidentate, the sutural tooth longer.

Habitat.—Japan (Honshu, Shikoku, and Kyushu); Formosa (Hori).

CALLICHROMINI

Genus CHLORIDOLUM Thomson

CHLORIDOLUM ACCENSUM (Newman).

Callichroma accensum NEWM., Entomologist 1 (1842) 246 (Manilla).

Large, highly variable in size; prothorax sharply tuberculate at side; elytra strongly narrowed posteriorly; head bluish green, antennæ violet; prothorax green with some violet tints above and with two approximate, slightly violet, black, triangular spots of velvet on center of disc, which together form an inverted equilateral triangle; scutellum bluish green; elytra frosted green, shiny vermiculose green near scutellum, with a velvety stripe of bluish green commencing near middle of base of each elytron, the two converging at first quarter and extending to apex along suture, and also a broader marginal stripe of velvety violet-blue to reddish violet extending from shoulder to apex; ventral surface silvery pubescent, the abdomen tinged with blue; legs red on fore and middle femora, except apices, basal half of hind femora and apical third of fore and middle tibiæ also red, remainder violet, except fore tarsi which are dull brown.

Two specimens in the author's collection taken on Botel-Tobago Island (Kotosho), east of the southern tip of Formosa, latitude 22° 5′ north, longitude 121° 35′ east, June 10, 1934, by Y. Izumi.

Habitat.—Philippines; Botel-Tobago Island (Kotosho).

This species is evidently common on the island, and has been misrecorded as *C. nympha* White.

CLYTINI

Genus AGLAOPHIS Thomson

AGLAOPHIS DECEMMACULATUS Gressitt sp. nov.

Narrow, laterally compressed; light, of a pale, cinereous color, each elytron marked with five black spots in four bands, the first band basal, of two spots, the next two bands close, and near the middle, the last before the apex; densely pubescent

except on spots; prothorax longer than broad, widest at apex, narrowed towards base.

Head vertical, densely clothed with light pubescence; frons quadrate; genæ granulose, their internal angles each with a node-like swelling; interantennal portion concave in middle and swollen at sides; occiput sunken; ventral lobe of eyes subglobular. Antennæ clothed with light gray pubescence and internally with moderate, flying hairs which become very scarce apically; equal in length to body; third segment moderately spined internally at apex, fourth segment hardly perceptibly spined; scape subcylindrical, apicomedially swollen, slightly arched; second segment two-fifths as long as scape, slightly swollen; third to fifth segments sightly swollen at apices; apical segments thickened; fourth segment two-thirds as long as third or fifth, which are subequal, sixth and seventh segments practically as long as third and fifth, succeeding segments slightly shorter. Prothorax narrow, broadest at apex; sides straight, vertical, not swollen; basal four-fifths as broad as apex; apex hardly narrower than head; dorsal surface greatly swollen, abruptly and vertically deflexed laterally; surface clothed with dense grayish green pubescence, which is sparse dorsally, showing granulose punctate surface. Elytra narrow, straight and flat dorsally, each with a narrow, longitudinal tubercle near base, strongly sloped at apices, sides strongly and vertically deflexed; apices transversely truncated, external angle armed with a strong spine, internal angle with a short tooth; surface clothed with dense grayish green pubescence except for five lacquerlike, black, subglabrous, subrugulose, punctate spots; deflexed portions sparsely clothed with pubescence; the first two spots basal, one on the shoulder, the other on the tubercle; third and fourth spots close, the former oblique, pointing posteriorly towards suture, placed slightly before middle, the latter transverse and medially placed, narrower; fifth spot one-fourth length from apex, subtransverse and rectangular; the last touching suture, the others not. Ventral surface clothed with light, silvery gray pubescence, except for anterolateral corner of metasternum, posterior edges of abdominal segments and base of first; first abdominal segment moderately long, second two-thirds as long as first and equal to fifth; third and fourth shorter; fore coxæ subglobular, prominent, intercoxal process much narrowed; mesosternal intercoxal process broad. Legs dark, clothed with light pubescence; trochanters and bases of femora reddish brown; femora moderately and fairly abruptly

clavate; fore and hind tibiæ with two short apical spines, middle pair with a single spine; tarsi two-thirds as long as tibiæ, first segment of middle pair equal to second and third segments combined, first segment of hind pair subequal to remaining segments combined.

Length, 9.7 millimeters; breadth, 2.3.

Holotype, a unique, in author's collection, taken at Hori, central Formosa, altitude 500 meters, October 19, 1933, by a native collector and sold to the author.

CLEOMENINI

Genus CLEOMENIDA Schwarzer

CLEOMENIDA PULCHELLA Gressitt sp. nov.

Small, narrow, parallel, setigerous, punctate; metallic green, the prothorax orange, with the basal constricted portion blackish green, the apical constricted portion blacker, tarsi brown beneath, submetallic above, antennæ with the scape metallic green, the rest brown with the second to fifth segments slightly tinged with green; clothed with long, erect, flying white hairs except on lateral portions of body and posterior half of elytra; antennæ, except two basal segments, furnished only with a row of hairs on the inner side, the hairs becoming scarcer posteriorly, the latter segments, except last, each with only a single apical hair.

Head narrow, broadest at eyes, moderately punctate except on neck, which is short and very slightly constricted; frons flat, broadest at bases of antennæ; clypeus and labrum narrow; genæ prominent; vertex broadly and shallowly concave between antenniferous tubercles, which are low, obtuse, and moderately distant; eyes with inferior lobes pear-shaped and superior lobes long and narrow, but distant. Antennæ (female) reaching to about the apical fifth of the elytra; the scape thick, bulb-shaped, thickest near the apex, not very narrow basally, the second segment similar in shape, third to fifth slightly swollen and globose at apices, remaining segments thickened gradually, but very slightly, towards apices, last segment blunt; second segment one-third as long as scape, scape two-thirds as long as third segment, fourth segment two-thirds as long as third and four-fifths as long as fifth, fifth to seventh subequal, eighth to eleventh shorter and subequal. Prothorax fairly twice as long as breadth at base, apex practically as broad as base, base three-fourths as broad as elytra at base; central portion swollen, nearly as broad

as elytra, subglabrous, reddish orange with faint lavender reflections, practically impunctate and very sparsely clothed with hairs above. Scutellum small, semicircular. Elytra narrow, flattened dorsally, rounded laterally, narrowed before middle; latter part as broad as base; margins concave; apices with both internal and external angles oblique, forming a blunt point in the middle. Underparts, except prothorax, metallic and punctate, ventral surface less so than lateral; first segment of abdomen slightly longer than second and third segments united. Legs with femora long, arched, very thin, pedunculate and clavate; fore femora swollen for more than the latter half of their length, middle femora swollen for less than half their length, hind femora swollen for the last quarter of their length, barely reaching beyond apex of abdomen; tibiæ shorter than femora; tarsi long, first segment of middle pair subequal to succeeding two segments united, first segment of hind tarsi one and one-half times as long as second and third united.

Length, 7.3 millimeters (7 to end of elytra); breadth, 1.1.

Holotype, a unique, probably a female, in the author's collection, taken at Riran, Formosa (east coast), latitude 23° 2′ north, altitude 250 meters, April 19, 1932, by the author.

This species agrees fairly well in structure with the genotype, *C. setigera* Schwarzer, also from Formosa, but differs from the latter in the smaller mandibles, thicker scape, less quadrate swollen portion of pronotum, more parallel elytra which are less narrowed posteriorly, less flattened dorsally, more rounded laterally, and less acute apically; also in having the femora swollen for shorter lengths and in the puncturation being more accentuated, the colors brighter, and the basal segments of the hind tarsi shorter.

LAMIINÆ

MONOCHAMINI

Genus MONOCHAMUS Guerin

MONOCHAMUS FLOCCULATUS Gressitt sp. nov.

Large and broad; blackish brown; surface uneven and clothed on elytra with many irregular areas of dense pubescence, giving the effect of many jet black or golden brown shiny spots, according to the angle of vision; a golden pubescent spot at middle of side of each tibia; entire body clothed with black pubescence and also very sparsely with single white hairs, one to each puncture on prothorax and elytra, more noticeable on ventral surface; tarsi ochraceous below.

Head with only a few strong punctures on frons, and some fine ones on labrum and bases of mandibles; frons subrectangular, slightly broader than high; clypeus very short, labrum large; antennal supports prominent; vertex strongly concave between them; occiput grooved medially; eyes in the shape of a curved gourd, grossly faceted. Antennæ (female) two-fifths longer than body, nearly naked; scape gradually thickened towards apex, cicatricized narrowly above; second segment broader than long, third segment one-third longer than scape or fourth segment; fifth to tenth segments subequal and slightly shorter than fourth, apical segment half again as long as tenth; third to seventh segments somewhat swollen at apices. Prothorax as long as broad, apex slightly narrower than base, base slightly more than half as broad as elytra at base; subacutely tuberculate at sides; surface punctate, very uneven, transversely impressed with a straight line near base and a curved line near apex, forming a depression beyond middle; disc with five swellings in the form of an inverted W, the middle three more prominent, the anterior two tuberculate and the medial one long, broadened posteriorly. Scutellum broader than long, rounded posteriorly. Elytra broadest at shoulders, slightly narrowed posteriorly, slightly more than twice as long as broad, apices subobliquely truncate with the sutural angles obtuse; surface with many irregular pubescent swellings and pits, deeply punctate basally, more finely posteriorly. Ventral surface impunctate; intercoxal process of mesosternum swollen and subvertical in front. Legs large; tibiæ strongly thickened at apices; tarsal segments broad, the third segment over half as long as last segment, claws not widely divergent.

Length, 25 millimeters; breadth, 9.5.

Holytype, a female, in the author's collection, taken at Hinokiyama, northern Formosa, altitude 1,500 meters, July 17, 1934, by Y. Izumi.

Genus CEREOPSIUS Pascoe

CEREOPSIUS PRAETORIUS (Erichson).

Lamia praetoria ERICH., Nova Acta Acad. Nat. Cur. 16 suppl. 1 (1834) 268, pl. 39, fig. 7; NEWMAN, Entomologist 1 (1842) 276 (*Monohammus* ?).

Broad, narrowed posteriorly; head deeply grooved between antennal supports; prothorax broader than long, sharply tuberculate laterally behind middle, constricted basally; antennæ nearly

twice as long as body in male, slightly longer in female, scape long, broadly thickened at apex, third and following segments gradually decreasing in length and thickness, hardly swollen at apices; elytral apices slightly rounded and subtransversely truncated; black, anterior portion of prothorax, and elytra, except base, apex and a broad spot in middle, testaceous-orange; clothed with a pale silvery pubescence beneath.

A specimen in the author's collection, taken at Imororu, Botel-Tobago Island (Kotosho), east of the southern tip of Formosa, latitude 22° 5′ north, June 6, 1934, by Y. Izumi.

GLENEINI

Genus GLENEA Newman

GLENEA LUTEICOLLE Gressitt sp. nov.

Narrow, subparallel; clothed completely beneath with a thin, but dense, dirty silvery white pubescence; top and front of head and prothorax above and at sides clothed with a dense pale orange pubescence; scutellum clothed with dense white pubescence; elytra black, clothed with a thinner, olive-gray pubescence; antennæ black, very thinly clothed with pale pubescence; most of body also sparsely clothed with fine, erect hairs, which are dark on dorsal surface of body and pale beneath, and present on antennæ only on the underside of basal segments and with single, apical ones on remaining segments.

Head fairly vertical in front; surface finely punctate; frons slightly higher than wide, rectangular; clypeus with anterior margin glabrous; labrum very short; vertex very slightly concave between antennal supports. Antennæ slightly longer than body; second and third segments only swollen at apices; scape short, subcylindrical, slightly thinner at base, second segment barely longer than broad; third segment nearly twice length of scape and one and one-half times as long as fourth; fourth to tenth segments subequal, gradually shorter; apical segment noticeably shorter than tenth, subfusiform. Prothorax subcylindrical, slightly swollen in middle, barely broader than long, slightly constricted at base, two-thirds as broad as elytra; regularly and minutely punctured. Scutellum longer than broad, subtrapeziform, rounded posteriorly. Elytra narrow, subparallel; slightly swollen on anterior part of disc; sides sharply deflexed, with three longitudinal costæ which disappear before apex, the middle one commencing after the first quarter, separated by two grooves each with a single line of punctures; dorsal surface punctured

fairly regularly in longitudinal lines, the punctures weaker posteriorly and disappearing before apex; apices narrowed and obliquely truncate, not toothed, the internal angles subobtuse. Ventral surface impunctate. Legs thin; femora very slightly swollen; first segment of fore and middle tarsi, respectively, equal in length to second and third combined, first segment of hind tarsi nearly as long as remainder of tarsi; claws small, reddish brown.

Length, 11.5 millimeters; breadth, 3.

Holotype, No. 50900, United States National Museum, collected by the author at Hassenzan, Formosa, altitude 1,900 meters, June 24, 1934; and one paratype in the author's collection.

A typical *Glenea;* very closely related in structure to *G. chrysomaculata* Schwarzer, of Formosa.

? GLENEA LATA Gressitt sp. nov.

Very broad, shortened, dorsoventrally compressed; elegant, of a rich golden chestnut-brown color; clothed with a thin golden pubescence, and short, erect, golden hair; marked with thick, creamy, yellowish white spots of dense scale hairs in the following manner: Prothorax above at each side with two approximate or connected spots of irregular shape, nearly inclosing a small blank circle between each pair, commencing near apex and extending to basal margin where they are broadest and approach each other closest; elytra with a round spot at middle of basal margin of each which is slightly broader than long; a second oval small spot at side before middle; a third large spot practically touching suture, longer than broad, broader than half of elytron, indented anterolaterally, and centered slightly before middle; a fourth subcircular spot, longer than broad, centered at beginning of last quarter and nearer margin than suture, second in size to the preceding one; and a fifth, small, transverse apical one; head with a narrow stripe behind the eye; two small spots, one before the other and smaller, at side of prothorax near coxal insertion; mesothorax with a moderate subtriangular spot covering most of episternum and part of epimeron; metepisternum with two spots, one before the other; and abdominal segments, except fourth, each with a round spot near lateral margin and nearly hidden by sides of elytra.

Head very short, broad, surface finely and evenly punctate; frons rectangular, broader than high; vertex broad, hardly depressed in middle; occiput swollen; eyes narrow, ventral lobe

subcircular. Antennæ one-third longer than body; distantly inserted; clothed with auburn hairs internally and at apex of each segment; scape cylindrical, narrowed at base; second segment longer than broad, third segment one and one-half times as long as scape and one-fourth again as long as fourth segment, fifth segment two-thirds as long as fourth, subequal to succeeding segments which gradually decrease in length to apex. Prothorax one and one-half times as broad as long; transversely impressed before and behind middle; posterior margin concave at each side of middle, surface evenly punctate. Scutellum as broad as long, rounded posteriorly. Elytra broad, slightly narrowed posteriorly; apices broadly rounded, internal angle nearly a right angle; surface moderately punctate, very finely near apex; sides evenly rounded, without ridges or grooves. Ventral surface slightly punctate before and at sides of thorax, microscopically on abdomen; last abdominal segment nearly as long as second to fourth segments combined. Legs short; tarsi small and narrow, hind pair hardly more than half as long as hind tibiæ, first segment equal to two succeeding segments combined, claws small, strongly divaricate and prominently toothed.

Length, 13.3 millimeters; breadth, 5.

Holotype, female, a unique, in the author's collection, taken by the author at Kuraru, in Koshun, near South Cape, Formosa, latitude 22° north, altitude 160 meters, May 6, 1934.

TETRAOPINI

Genus CHREONOMA Pascoe

CHREONOMA ATRITARSIS Pic.

Chreonoma atritarsis PIC, Mat. Longicornes 8 2 (1912) 21.

Subparallel, very slightly broadened posteriorly; testaceous, the elytra deep metallic blue to violaceous, marked with black on antennæ, except for basal portions of first four segments; apices of mandibles, tarsi, and apices of tibiæ also black; clothed on body and on antennæ internally with long erect hairs, which are long basally and short apically on elytra and light-colored on the pale areas and black on the dark areas.

Head broad, shiny, very sparsely punctate, shallowly concave between the antennal supports. Antennæ five-sixths as long as the body; scape broadened and slightly flattened, punctate basally and sharply rugulose apically; second segment twice as long as broad; third segment as long as scape; fourth segment two-thirds as long as third; fifth to tenth slightly diminishing and

eleventh longer, finely attenuated and suggesting two segments. Prothorax short, greatly swollen on disc and at sides in middle, the swollen portion of disc grossly punctate and projecting slightly posteriorly. Scutellum short, broadly rounded posteriorly. Elytra fairly evenly punctate except at apices. Ventral surface minutely punctate at sides; fore coxæ contiguous, intercoxal process of mesosternum narrow, extending posteriorly four-fifths of space between coxæ; second segment of tarsi less than half as long as either first or third segments.

Length, 11 millimeters; breadth, 3.5.

One specimen collected by the author at Hassenzan, Formosa, altitude 1,100 meters, June 20, 1932; another specimen collected by the author at Kusukusu, southern Formosa, altitude 150 meters, April 13, 1932.

This species differs from *C. fortunei* Thomson in the larger size, wider body, more swollen prothorax, violaceous elytra, black tarsi, lighter bristles of the anterior regions, and in the primary antennal segments being part yellow instead of wholly black.

Habitat.—China (?); Formosa (Hassenzan, Kusukusu). Doubtfully recorded from China by Pic in the original description. New to Formosa.

Genus ANASTATHES Gahan

ANASTATHES PARVA Gressitt sp. nov.

Small, parallel-sided; entirely of a shiny, ochraceous-yellow color except for antennæ, eyes, mandibles, and outer edges of tibiæ, which are black; body, legs, and basal three segments of antennæ nitid and shiny; body and legs clothed with suberect golden hairs, densest on frons and pygidium, sparsest on sides of pronotum and more reclining on elytra.

Head broad, swollen in front, nearly flat between antennal insertions; surface fairly evenly punctate; ventral part of eyes nearly round, dorsal part oval, sublongitudinal; last segment of the maxillary palpi nearly twice as long as the preceding segment. Antennæ (male) extending very slightly beyond the elytral apices; clothed with flying brownish black hairs on first three segments, and on inner sides and apices of remaining segments; first three segments subglabrous, densely and finely punctulate, remaining segments subopaque, finely granulose; scape subcylindrical, very slightly thickened towards apex; second segment hardly as long as broad; third segment slightly longer than scape, very slightly swollen at apex; fourth segment two-thirds as long as scape; fifth to tenth segments successively

slightly shorter, cylindrical, and not thickened at apices; apical segment slightly longer than tenth, finely and acutely pointed at apex. Prothorax one-third again as broad as long; middle portion transversely and rather feebly swollen; surface rather irregularly punctate. Scutellum very short and broad, rounded posteriorly; finely punctate. Elytra parallel-sided, rounded apically, shiny; punctured in nine or ten longitudinal rows. Ventral surface punctured slightly at sides only; intercoxal process of prosternum nearly reaching level of coxæ; intercoxal process of mesosternum subvertical in front, its posterior margin with a concavity into which fits the apex of the metasternal process, which extends anteriorly more than halfway between the coxæ. Legs with the tarsi very narrow, the second segment smaller than third, which is slightly smaller than first.

Length, 7.5 to 9 millimeters; breadth, 2.3 to 2.75.

Holotype, male, No. 50901, United States National Museum, taken by the author at Bukai, near Hori, central Formosa, altitude 1,000 meters, June 12, 1934; two paratopotypes taken the same day, and a third paratype taken at Hori, Formosa, altitude 650 meters, June 9, 1934, in the author's collection.

This species agrees fairly well with the essential characters of the genus, hitherto recorded from Siam, Malacca, and Java, particularly in the structure of the intercoxal processes; however, the third antennal segment is not shorter than the scape, and the prothorax is meagerly swollen above and at sides.

JAPANESE NAMES

Noemia incompta sp. nov. Taiwan-hoso-kamikiri-(mushi).
Oplatocera oberthuri Gahan. Naname-suji-kamikiri.
Hemadius oenochrous Fairmaire. Musha-miyama-kamikiri.
Pseudaeolesthes chrysothrix (Bates). Ki-madara-kamikiri.
Chloridolum accensum (Newman). Ō-midori-kamikiri.
Aglaophis decemmaculatus sp. nov. Hori-shiro-heri-kamikiri.
Cleomenida pulchella sp. nov. Ao-kenaga-kamikiri.
Monochamus flocculatus sp. nov. Futo-higenaga-kamikiri.
Cereopsius praetorius (Erichson). Koto-futo-kamikiri.
Glenea luteicolle sp. nov. Hoshi-nashi-kamikiri.
Glenea lata sp. nov. Futo-hoshi-kamikiri.
Chreonoma atritarsis Pic. Taiwan-ruri-kamikiri.
Anastathes parva sp. nov. Bukai-kamikiri.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXVI[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The majority of the species of crane flies discussed in the present report are from western China, where they were collected by the Rev. Mr. George M. Franck and by the Rev. Mr. David C. Graham. A further considerable series was taken in Formosa and the Loochoo Islands by Mr. J. Linsley Gressitt. Smaller series were taken in eastern China by Mr. E. Suenson and in Formosa by Prof. Teiso Esaki. One further interesting species from Siam was sent to me for study from the American Museum of Natural History, through the friendly interest of Dr. C. Howard Curran. The extensive Graham collections are preserved in the United States National Museum, the other species in my own collection of Tipulidæ. As a result of the present survey, four generic groups are added to the Tipuloidea of China; namely, *Ptychoptera, Paracladura, Phalacrocera,* and *Gymnastes*. For convenience of treatment I have included various records of the tipuloidean families Ptychopteridæ and Trichoceridæ in the present discussion.

PTYCHOPTERIDÆ

PTYCHOPTERA CLITELLARIA sp. nov. Plate 1, fig. 1.

General coloration of thorax yellow, the entire præscutum solidly black, brightened only on the humeral portions; femora yellow, the tips black; wings with a strong brownish yellow tinge, very restrictedly and sparsely patterned with brown; Rs relatively long, about three-fourths the length of R_{4+5}; basal abdominal tergites yellow, black medially, the outer segments uniformly blackened.

[1] Contribution from the entomological laboratory, Massachusetts State College.

Female.—Length, about 11 millimeters; wing, 11.5.

Rostrum yellow; palpi brown, the terminal segment brownish black. Antenna broken beyond the brown scapal segment. Head black, the front more reddish brown.

Pronotum yellow. Mesonotal præscutum yellow, the entire disk covered by a polished black area, restricting the ground to narrow humeral and anterolateral brightenings; scutum, scutellum, and mediotergite light yellow. Pleura entirely light yellow. Halteres dusky. Legs with the coxæ and trochanters yellow; femora yellow, the tips black, including about the distal eighth; tibiæ dark brown, the tips black; tarsi black (a single leg, middle, remains). Wings (Plate 1, fig. 1) with a strong brownish yellow tinge, cells C and Sc, together with the prearcular field, clearer yellow; very tiny to scarcely evident brown spots along cord and at forks of R_{4+5} and M_{1+2}; veins dark brown, brighter in the flavous areas. Macrotrichia of cells distributed about as figured (shown by stippled dots). Venation: Rs relatively long, about three-fourths the length of R_{4+5}; r-m connecting with Rs just before fork; cell M_1 small.

Abdominal tergites one to four yellow laterally, black medially; on outer segments, the entire dorsum black; basal sternites yellow, the outer segments and ovipositor black, only the outer ends of cerci more reddish.

Habitat.—China (Szechwan).

Holotype, female, Yachow, 1930 (*Graham*).

Ptychoptera clitellaria is readily told from all other described species of the genus by the peculiar coloration of the præscutum and abdomen. The family had not been recorded from China.

TRICHOCERIDÆ

TRICHOCERA ARISANENSIS Alexander.

Trichocera arisanensis ALEXANDER, Philip. Journ. Sci. 56 (1935) 339.

Described from the high mountains of Formosa. Mount Omei, Szechwan, altitude 10,800 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

PARACLADURA ELEGANS Brunetti.

Paracladura elegans BRUNETTI, Rec. Indian Mus. 6 (1911) 288.

Described from the eastern Himalayas. Mount Omei, Szechwan, altitude 11,000 feet, August 18, 1934 (*Graham*).

PARACLADURA GRACILIS Brunetti.

Paracladura gracilis BRUNETTI, Rec. Indian Mus. 6 (1911) 287.
Trichocera flava BRUNETTI, Fauna Brit. India, Diptera Nematocera (1912) 512.

Described from the eastern Himalayas. Mount Omei, Szechwan, altitude 11,000 feet, August 18, 1934 (*Graham*).

PARACLADURA OMEIENSIS sp. nov. Plate 1, fig. 2.

General coloration of mesonotum brownish yellow, the præscutum darkened medially; pleura darkened; antennal flagellum black; knobs of halteres dark brown; wings grayish yellow, the veins pale brown; abdominal tergites dark brown.

Female.—Length, about 3.5 to 3.7 millimeters; wing, 3.8 to 4.3.

Rostrum and palpi dark. Antennæ with scape orange-yellow; remainder of antenna black. Head pale brown.

Mesonotum chiefly brownish yellow, the præscutum conspicuously darkened medially; posterior sclerites of mesonotum pale. Pleura rather strongly darkened, paler in one of the paratypes. Halteres dusky, the base of stem yellow, the knob dark brown. Legs with the coxæ and trochanters pale; remainder of legs pale brown, the outer tarsal segments somewhat darker. Wings (Plate 1, fig. 2) uniformly suffused with grayish yellow; stigma lacking; veins pale brown. Venation: M_{3+4} forking at near midlength of cell 1st M_2; m-cu on M_4 some distance beyond base.

Abdominal tergites dark brown, the sternites paler. Ovipositor with the cerci broad-based, the distal third strongly narrowed.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, 1 female, 1 broken, altitude 5,500 to 10,800 feet, August 18, 1934 (*Graham*).

Paracladura omeiensis is readily distinguished from *P. gracilis* Brunetti by the much darker coloration of the body and appendages.

TIPULIDÆ

TIPULINÆ

TIPULA (FORMOTIPULA) UNIRUBRA sp. nov. Plate 1, fig. 3; Plate 2, fig. 25.

Mesonotum black, with three grayish stripes, the median one divided by parallel capillary dark vittæ for about the cephalic

half; scutellum and mediotergite heavily pruinose; legs black; wings with a uniform grayish brown suffusion, cell Sc darker than cell C; Rs exceeding m-cu; abdomen black, the segments pruinose, segment two reddish orange; male hypopygium with the tergite notched medially; dististyle complex, with two blackened spines on posterior margin.

Male.—Length, about 13 millimeters; wing, 15.

Female.—Length, about 13 to 14 millimeters; wing, 15 to 16.

Rostrum and palpi black, sparsely pruinose. Antennæ black, the pedicel a trifle paler; verticils longer than the segments. Head black, sparsely pruinose behind.

Mesonotal præscutum black, with three grayish stripes, the median one divided by parallel capillary black vittæ that occupy about the cephalic half of the sclerite, the stripe being entire behind; scutum, scutellum, and mediotergite obscure, heavily pruinose. Pleura black, more pruinose on ventral sternopleurite. Halteres black. Legs with the coxæ and trochanters dull black; remainder of legs black, the extreme base slightly brightened. Wings (Plate 1, fig. 3) with a uniform grayish brown suffusion; cell Sc distinctly darker than cell C; stigma oval, darker brown; veins brownish black. Venation: Rs longer than usual in the subgenus, exceeding m-cu; R_{1+2} with trichia on basal fifth; m-cu elongate, at fork of M_{3+4}.

Abdomen black, the second tergite reddish orange, the corresponding sternite more obscure brownish red; basal tergite vaguely brightened medially; third and succeeding segments black, sparsely pruinose, without brightening; hypopygium and ovipositor black.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female. Paratopotypes, 2 females.

The nearest ally is apparently *Tipula* (*Formotipula*) *rufizona* Edwards (western China), which has the præscutum with four complete blackish gray stripes and with the orange color of the abdomen including parts of the third and fourth tergites. The present fly is very different from *T.* (*F.*) *friedrichi* Alexander and *T.* (*F.*) *holoserica* Matsumura in the notched ninth tergite of the male hypopygium.

NEPHROTOMA BIARMIGERA sp. nov. Plate 1, fig. 4; Plate 2, fig. 26.

General coloration yellow; occipital brand not or scarsely indicated; præscutum with three polished black stripes; scutellum

yellow; mediotergite yellow, the posterior border a little more reddish; pleura yellow, variegated by more reddish areas; halteres pale yellow; femora yellow, the tips not or scarcely darkened; wings with a pale yellow suffusion; abdomen yellow, the tergites trivittate with black, the median stripe broad but interrupted; subterminal segments black; male hypopygium with a heavily blackened, slightly bifid lobe from the ventromesal portion of basistyle.

Male.—Length, 11 to 12 millimeters; wing, 12 to 13.

Female.—Length, about 15 millimeters; wing, 13.5.

Frontal prolongation of head yellow; outer half of dorsal surface, including nasus, darkened; palpi chiefly pale. Antennæ with the scape light yellow; pedicel pale brown; flagellar segments brownish black, relatively elongate and moderately incised; verticils shorter than the segments. Head with the vertical tubercle yellow, darker posteriorly; remainder of head more orange-yellow; occipital brand not or scarcely indicated.

Pronotum and pleura orange-yellow. Mesonotal præscutum light yellow, with three polished black stripes that are very narrowly bordered by more velvety black; lateral stripes weakly outcurved with velvety black; in female, median stripe with cephalic half narrowly divided by more reddish brown; scutum yellow, each lobe chiefly polished black, narrowly bordered by more velvety black; scutellum yellow; mediotergite light yellow, the posterior border with more reddish, paired areas. Pleura yellow, variegated by more reddish areas on anepisternum, ventral sternopleurite, meron, and posterior portions of pleurotergite. Halteres pale yellow, the base of each knob weakly darkened. Legs with the coxæ and trochanters yellow; femora yellow, the tips not or scarcely darkened; tibiæ and basitarsi brownish yellow, the tips of the latter, together with remainder of tarsi, black. Wings (Plate 1, fig. 4) with a pale yellow suffusion; stigma medium brown; a very vague and restricted dark cloud on anterior cord; veins brown, paler in prearcular field. Venation: Sc_2 ending just beyond origin of Rs; cell M_1 very short-petiolate to narrowly sessile; M_4 departing shortly before fork of M_3, m-cu on base of former.

Abdomen yellow, the tergites trivittate with black, the areas interrupted at the bases of the segments; median stripe broad and conspicuous, beginning on the first tergite; segments seven and eight, and the central portion of tergite nine black, the remainder of hypopygium pale. In female the tergal areas more

expanded on posterior portion of segments to form triangles. Male hypopygium with the caudal border of tergite (Plate 2, fig. 26, 9*t*) almost evenly, convexly rounded, without projecting horns or lobes. Outer dististyle, *od*, not markedly attenuate at apex. Inner dististyle, *id*, broad, with two blackened lobes, additional to the slender beak; surface with conspicuous setæ. Basistyle at ventromesal portion produced into a blackened lobe, *b*, the apex slightly bifid, the surface microscopically corrugated. A pale membranous median lobe, directed cephalad, from outer portion of eighth sternite.

Habitat.—China (Chekiang).

Holotype, male, hills south of Ning-po, halfway to Nimrod Sound, May 1, 1925 (*Suenson*). Allotopotype, female. Paratopotype, male.

Nephrotoma biarmigera is most generally similar to species such as *N. citrina* Edwards and *N. nigricauda* Alexander, differing from both in the coloration. The peculiar blackened lobe on the basistyle of the male hypopygium is very different from the condition in any other regional *Nephrotoma* that I have examined.

NEPHROTOMA EVITTATA sp. nov. Plate 1, fig. 5; Plate 2, fig. 27.

Allied to *impigra;* general coloration yellow; frontal prolongation of head yellow, unmarked; palpi pale yellow; flagellar segments (male) strongly incised; occipital brand undifferentiated; mesonotal præscutum with three polished black stripes; mediotergite yellow; wings whitish subhyaline, cell Sc uniformly dark brown; stigma pale brownish yellow; abdomen orange, without a median tergal stripe but with pale brown areas on sides of tergites two to five, inclusive; hypopygium pale; male hypopygium with the eighth sternite very weakly emarginate, with a small rounded cushion in the notch, the setæ surrounding the emargination unusually sparse and not of unusual length.

Male.—Length, about 8.5 millimeters; wing, 9.

Frontal prolongation of head yellow, the dorsal surface and nasus not or scarcely darkened; setæ of nasus black; palpi pale yellow throughout. Antennæ with basal three segments yellow, the remainder of flagellum black; antenna relatively long, if bent backward extending approximately to base of abdomen; flagellar segments rather strongly incised; verticils shorter than

the segments. Head orange, the occipital brand not differentiated; posterior genæ a little paler.

Pronotum yellow throughout. Mesonotal præscutum yellow, with three polished black stripes, each of the lateral pair with a much paler brown spot outside its anterior end; scutum yellow, the lobes extensively blackened, the color involving the outer end of the suture and the adjoining lateral portion of the scutal lobe as a velvety-black U-shaped line; scutellum weakly infumed, the parascutella yellow; mediotergite yellow, the posterior border vaguely more reddish yellow. Pleura light yellow, with very vague, more reddish areas on anepisternum, ventral sternopleurite, ventral meron, and posterior portion of pleurotergite. Halteres pale brown, the apices of knobs light yellow. Legs with the coxæ and trochanters yellow; femora yellow, the extreme tips darkened; tibiæ yellow, the outer ends passing into black; tarsi broken. Wings (Plate 1, fig. 5) whitish subhyaline; cell Sc uniformly dark brown; stigma pale brownish yellow; veins dark brown. Venation: Sc_2 ending just beyond origin of Rs, Sc_1 preserved; cell M_1 very short-petiolate; M_4 departing a short distance before M_3; m-cu on M_4 just beyond its base.

Abdomen entirely orange, without indications of a median dark tergal stripe but with pale brown lateral areas on tergites two to five, inclusive; hypopygium entirely pale. Male hypopygium with the tergite (Plate 2, fig. 27, 9*t*) bearing two slender acute lateral spines, each with about three blackened denticles near base. Outer dististyle, *od*, pale throughout, not greatly attenuated, the setæ relatively sparse and inconspicuous. Inner dististyle, *id*, relatively slender, the apical beak long and narrow. Eighth sternite, 8*s*, with a very small median notch that bears a tiny rounded cushion set with abundant microscopic setulæ; setæ of sternite surrounding this emargination very sparse and of ordinary length.

Habitat.—China (Szechwan).

Holotype, male, Shin-Kai-Si, Mount Omei, altitude 4,400 feet (*Graham*).

The present fly is allied to *Nephrotoma impigra* Alexander (western China), differing notably in the coloration of the body, as the lack of a dark median stripe on the abdominal tergites. The details of the male hypopygium are distinctive.

NEPHROTOMA DEFINITA sp. nov. Plate 2, fig. 28.

General coloration yellow; antennal scape and pedicel yellow, flagellum black; head orange, the occipital brand small and inconspicuous, reddish brown; mesonotal præscutum yellow, with three piceous-black stripes, the anterior half of the median stripe paling to reddish brown; posterior half of mediotergite darkened; knobs of halteres yellow; femora yellow, the extreme tips dark brown; wings whitish, stigma and cell Sc darkened; abdomen orange, the median region of tergite two and base of sternite eight blackened; hypopygium orange; eighth sternite long and sheathing, the caudal margin unmodified.

Male.—Length, about 12 millimeters; wing, 10.5.

Female.—Length, about 18 millimeters; wing, 13.

Frontal prolongation of head yellow, more reddish above; nasus pale; palpi with the basal two segments slightly darkened, the outer segments yellow. Antennæ with scape and pedicel yellow, the flagellum black; flagellar segments very weakly incised. Head orange, the vertical tubercle more yellowish; occipital brand small and inconspicuous, reddish brown; in female, with a narrow dark vitta to summit of vertical tubercle.

Pronotum yellow medially, darkened laterally. Mesonotal præscutum yellow, with three polished piceous-black stripes, the anterior half of the median stripe paling to reddish brown; lateral stripes straight; scutum yellow, each lobe with two black areas; central portion of suture blackened, sending a short median line caudad onto the scutum to form a Y-shaped figure; a narrow black streak before wing root; scutellum brown, parascutella yellow; mediotergite yellow, with nearly the posterior half occupied by a transverse-oval dark area. Pleura yellow, variegated by dark reddish on propleura, anepisternum, ventral sternopleurite, and meron; dorsal and ventral pleurotergite similarly colored. Halteres dark, the base of stem restrictedly pale, the knob chiefly yellow. Legs with the coxæ and trochanters reddish yellow; femora yellow, the extreme tips narrowly but conspicuously dark brown; tibiæ yellow, the tips narrowly darker; tarsi passing into black. Wings whitish; stigma, cell Sc, and the narrow cell Cu_1 dark brown; veins brown. Stigma with a few trichia. Venation: Sc_1 preserved; Rs short; M_4 arising at the same point as M_3; cell M_1 sessile.

Abdomen orange, the median region of tergite two and base of sternite eight blackened; hypopygium orange, reduced in size. In female the tergal darkened areas a little more extensive.

Male hypopygium with the tergite (Plate 2, fig. 28, *9t*) produced into two lateral horns that merge into the thickened caudal margin, densely set with spines and stout setæ. Outer dististyle, *od*, relatively small, pale throughout, including the setæ. Inner dististyle, *id*, relatively narrow, the outer border unmodified. Ninth sternite reduced in area. Eighth sternite long and sheathing, the caudal margin unmodified.

Habitat.—Formosa.

Holotype, male, Sumaän, altitude 2,500 feet, August 21, 1921 (*Esaki*). Allotopotype, female, returned to Professor Esaki.

The coloration of the præscutum is somewhat as in the much smaller and otherwise very distinct *Nephrotoma parva* (Edwards).

NEPHROTOMA CAUDIFERA sp. nov. Plate 1, fig. 6; Plate 2, figs. 29, 30.

General coloration yellow; mesonotal præscutum with three polished black stripes, each of the lateral pair with a velvety-black spot at its anterior end; head orange throughout, with no occipital brand; halteres dusky throughout; wings with a brownish tinge, the stigma not or scarcely darker; about a dozen stigmal trichia in cell R_1; abdomen orange-yellow, the seventh and eighth tergites weakly darkened; inner dististyle of hypopygium with a long, pale, tail-like extension behind; ninth sternite with a large, median, cushionlike lobe.

Male.—Length, about 10 millimeters; wing, 10.5.

Frontal prolongation of head yellow, the dorsum, including nasus, darkened; palpi dark brown. Antennæ of moderate length, if bent backward extending to shortly beyond wing root; scape orange-yellow; pedicel reddish brown; flagellum black; flagellar segments moderately incised; verticils shorter than the segments. Head orange throughout; no occipital brand.

Pronotum entirely yellow. Mesonotal præscutum yellow, with three polished black stripes, each of the lateral pair with a velvety-black outward extension opposite its anterior end; scutum yellow, the lobes chiefly polished black, the outer ends of suture restrictedly velvety black; scutellum brown, parascutella yellow; mediotergite yellow, without evident darkenings. Pleura yellow, the ventral sternopleurite a little more reddish. Halteres dusky throughout. Legs with the coxæ and trochanters yellow; femora obscure yellow; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 6) with a brown tinge, the stigma not or scarcely darker, with about a dozen trichia in cell R_1; prearcular region a trifle more yellowish; veins dark brown. Vena-

tion: Sc_2 ending opposite origin of Rs, Sc_1 represented by a slight spur; cell M_1 narrowly sessile; M_4 a short distance before fork of M_3, with m-cu shortly beyond base of M_4; cell 2d A relatively narrow.

Abdomen orange-yellow, very indistinctly marked with darker, only the seventh and eighth tergites weakly infumed. Male hypopygium with the ninth tergite (Plate 2, fig. 29, 9*t*) having the lateral spines, as viewed from above, slender, with two teeth near base; intermediate lobes with abundant spines. Outer dististyle (Plate 2, fig. 30, *od*) relatively broad across basal half, the apex slightly attenuated. Inner dististyle, *id,* very high, with a long, pale, caudal extension. Ninth sternite with a large, protuberant, median cushion. Eighth sternite with the posterior margin transverse, unmodified.

Habitat.—Formosa.

Holotype, male, Hassensan, altitude 5,500 feet, July 7, 1934 (*Gressitt*).

Nephrotoma caudifera is somewhat similar to species such as *N. flammeola* Alexander and *N. subpallida* Alexander, of Japan, but is very distinct in the details of coloration and structure of the male hypopygium, notably the inner dististyle.

NEPHROTOMA NIGROSTYLATA sp. nov. Plate 1, fig. 7; Plate 2, fig. 31.

General coloration yellow; præscutum with three polished black stripes, each of the lateral pair with a velvety-black spot opposite its anterior end; antennæ (male) relatively long; occiput and vertex with a linear black vitta almost to summit of vertical tubercle; mediotergite yellow, the posterior border darkened; abdomen yellow, the tergites with three black stripes, the sternites with a median, interrupted black stripe; hypopygium black, including the styli; margin of outer dististyle provided with weak denticles; eighth sternite with a tonguelike, median, yellow lobe.

Male.—Length, 10 millimeters; wing, 9.5; antenna, about 4.

Female.—Length, 11 to 12 millimeters; wing, 11 to 11.5.

Frontal prolongation of head polished yellow, the dorsal surface more darkened, the color involving the nasus; palpi black. Antennæ (male) relatively elongate, if bent backward extending to shortly beyond the base of abdomen; basal three segments yellow, the flagellum very weakly bicolorous; basal enlargements of the segments black, the remainder dark brown; flagellar seg-

ments not or scarcely incised; verticils shorter than the segments. Head orange, the occipital brand appearing as a narrow brownish black line that extends cephalad almost to summit of vertical tubercle.

Pronotum obscure yellow, narrowly blackened laterally. Mesonotal præscutum yellow, with three polished black stripes that are not bordered; a velvety-black spot opposite the anterior end of the lateral stripes; scutal lobes very extensively blackened, attaining the suture, the lateral ends of the latter more velvety black; scutellum brownish black medially, the parascutella somewhat paler; mediotergite yellow, the posterior border darkened. Pleura yellowish white, more reddish on the ventral anepisternum, ventral sternopleurite, meron, and posterior portion of pleurotergite. Halteres dusky, the tips of the knobs obscure yellow. Legs with the coxæ and trochanters yellow, the posterior coxæ a little darkened basally; femora and tibiæ yellow, the tips very narrowly darkened; tarsi brown basally, passing into black. Wings (Plate 1, fig. 7) with a faint yellow tinge; prearcular region and cells C and Sc clearer yellow; stigma oval, brown; wing tip vaguely but rather evidently darkened; a very narrow seam on anterior cord; veins brown, more flavous in the yellow regions. Venation: Sc_2 extending a short distance beyond origin of Rs, Sc_1 weakly preserved; Rs shorter than R_{2+3}; cell M_1 with a short to longer petiole; m-cu shortly before M_4, the latter a corresponding distance before the point of departure of M_3.

Abdomen yellow, the tergites narrowly but conspicuously trivittate with black, the median stripe broader, especially behind, the dark color narrowly interrupted at the bases of the segments; sternites yellow, with a narrow, interrupted, black, median stripe; eighth and ninth segments entirely blackened, including the styli but not the appendage of the eighth sternite. Male hypopygium with the caudal margin of the ninth tergite (Plate 2, fig. 31, 9*t*) produced into lateral flattened black lobes, their mesal edges coarsely toothed. Outer dististyle, *od,* slender, blackened, slightly narrowed outwardly, the tip curved and subacute, the margin of style with three or four weak denticles. Inner dististyle, *id,* of peculiar shape, as figured, black throughout; posterior margin with abundant, long, pale setæ. Eighth sternite with a median, yellow, elongate-triangular, tonguelike lobe, its surface microscopically pubescent.

Habitat.—China (Szechwan).

Holotype, male, Chungking, altitude 1,000 to 2,000 feet, May 6 to 27, 1930 (*Graham*). Allotopotype, female. Paratopotypes, 12 of both sexes.

Nephrotoma nigrostylata is very different from all other described regional species. The tonguelike lobe on the eighth sternite is somewhat like that in *N. ligulata* Alexander and *N. parvirostra* Alexander, but in all other regards the present fly is very distinct.

CYLINDROTOMINÆ

PHALACROCERA MINUTICORNIS sp. nov. Plate 1, fig. 8.

General coloration yellow, the vertex black; antennæ of both sexes unusually small, with long conspicuous verticils; mesonotal præscutum with four polished black stripes, the intermediate pair almost confluent; halteres elongate, brownish black; wings long and narrow, with a strong, almost uniform, brown tinge; R_{1+2} entirely atrophied; m-cu beyond fork of M; cell 2d A unusually narrow.

Male.—Length, about 10 millimeters; wing, 9.8.

Female.—Length, about 10 millimeters; wing, 10.

Rostrum very small, brown; palpi black. Antennæ very small and subequal in both sexes, if bent backward ending some distance before wing root; scape yellow, pedicel and flagellum dark brown; flagellar segments subcylindrical to cylindrical, with long conspicuous verticils that are much longer than the segments. Head yellow on front and occiput, the vertex polished black, the posterior orbits narrowly pale.

Pronotum yellow. Mesonotal præscutum yellow, with four polished black stripes, the intermediate pair closely approximated, being separated only by a very vague capillary vitta; scutum pale, the lobes with black centers, the median pale area very broad; scutellum and mediotergite obscure yellow. Pleura yellow. Halteres elongate, brownish black, the base of stem narrowly yellow. Legs with the coxæ and trochanters yellow; femora obscure yellow, brighter at base, the tip passing into brownish black; tibiæ and tarsi black. Wings (Plate 1, fig. 8) long and narrow, with a strong and almost uniform brown tinge, the long-oval stigma slightly darker brown; veins dark brown. Venation: Sc_1 lacking; free tip of Sc_2 present but faint; R_{1+2} entirely atrophied; m-cu variable in position, from more than one-half to nearly its own length beyond fork of M; cell 2d A unusually narrow, with a distinct fold behind the vein.

Abdomen with the basal segments obscure brownish yellow, the outer segments and hypopygium black.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Allotopotype, female.

Phalacrocera minuticornis is allied to the Japanese and Formosan species, *P. formosæ* Alexander, *P. megacauda* Alexander, and *P. mikado* Alexander, differing in the narrow, strongly suffused wings, with very narrow cell 2d A, and in the unusually small antennæ in both sexes.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) PRUDENTIA sp. nov. Plate 1, fig. 9; Plate 3, fig. 32.

General coloration of mesonotal præscutum reddish brown, with three brownish black stripes; antennal flagellum black; femora black, with a conspicuous yellow subapical ring; wings light yellow, heavily patterned with brown, including longitudinal seams and streaks; a darker brown area at fork of Sc; Sc long, Sc_2 at tip of Sc_1; R_{1+2} subequal to $Sc_2 + R_1$; m-cu about one-half its length before fork of M; male hypopygium with the ninth tergite deeply emarginate; dististyle small, the basal half globular.

Male.—Length, about 9 millimeters; wing, 11.

Rostrum and palpi black, the former moderately long, exceeding one-half the length of head. Antennæ black, the pedicel a little paler, more yellowish brown; flagellum moderately elongate; segments with weak basal enlargements; longest verticils a little exceeding the segments. Head black; anterior vertex narrow.

Pronotum brownish black. Mesonotal præscutum reddish brown, with three brownish black stripes, the median stripe paling into the ground color on anterior portion; humeral and outer marginal portions of præscutum narrowly blackened; scutal lobes blackened, the median area pale; scutellum and mediotergite chiefly blackened, the latter paler on sides. Pleura chiefly blackened on dorsal portions, including the dorsopleural membrane, the ventral sternopleurite paler. Halteres with base of stem and apex of knob more yellowish. Legs with the fore and middle coxæ brownish black, the posterior coxæ paler; trochanters obscure yellow; femora yellow basally, soon passing into black, with a broad, light yellow, subterminal ring that is some-

what wider than the black apex; tibiæ brownish yellow, the tips narrowly blackened; tarsi black, the proximal ends of basitarsi restrictedly pale; legs relatively long and slender; claws (male) with three or four teeth on basal half. Wings (Plate 1, fig. 9) light yellow, heavily patterned with brown, including seams to the veins and longitudinal streaks in the centers of the cells, the dark color somewhat more extensive than the ground; a small, darker brown spot at fork of Sc; stigma not darker than the remaining pattern of the wings; the pale ground color includes an oblique crossband beyond cord, extending from costa into cell M_4, interrupted only by very narrow seams to the longitudinal veins; cell 2d A darkened except at outer end; veins yellowish brown. Venation: Sc long, Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; Rs long; R_{1+2} subequal to $Sc_2 + R_1$ and R_{2+3}; m-cu about one-half its length before fork of M.

Abdomen brownish black, the styli of the hypopygium more yellow. Male hypopygium (Plate 3, fig. 32) with the tergite, *9t,* broad basally, strongly narrowed outwardly, the caudal margin with a deep rounded emargination, the lateral lobes formed very narrow. A single dististyle, *d,* this relatively small and globular on basal half, the outer portion or beak stout, with numerous small setæ but without spines. Ædeagus, *a,* broad.

Habitat.—China (Szechwan).

Holotype, a broken male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*).

The nearest allies of the present fly seem to be *Limonia* (*Limonia*) *kashmirica* Edwards and *L.* (*L.*) *synempora* Alexander, which differ conspicuously in the body coloration, venation, especially of the medial field, and in the details of the hypopygium.

LIMONIA (DICRANOMYIA) VETERNOSA sp. nov. Plate 1, fig. 10; Plate 3, fig. 33.

General coloration of thorax yellow, with a dark brown median stripe on pronotum and præscutum; antennæ black throughout; halteres dark brown; wings whitish subhyaline; stigma relatively small, ill-delimited, dark brown; Sc_1 long; abdominal tergites and hypopygium brownish black, the basal sternites yellow; male hypopygium with the basistyle and ventral dististyle complicated by outgrowths.

Male.—Length, 6.5 to 7 millimeters; wing, 7 to 7.5.

Female.—Length, 8 to 9 millimeters; wing, 8 to 8.5.

Rostrum dark brown; palpi black. Antennæ black throughout; flagellar segments long-oval. Head yellowish gray.

Pronotum dark brown above, the sides yellow pollinose. Mesonotal præscutum yellow pollinose, with a conspicuous, dark brown, median stripe extending from the pronotum, as described, becoming obsolete before the suture; scutum and scutellum pale, the mediotergite more darkened. Pleura and pleurotergite yellow pollinose. Halteres dark brown, the base of stem yellow. Legs with the coxæ and trochanters yellow; femora yellow basally, the remainder brown with the tips rather narrowly black, the fore femora more uniformly blackened; tibiæ and tarsi blackened, in cases the former somewhat paler in central portions. Wings (Plate 1, fig. 10) whitish subhyaline; stigma relatively small and ill-delimited, dark brown; veins dark brown. Venation: Sc_1 ending opposite origin of Rs, Sc_2 some distance from its tip, Sc_1 alone subequal to or only a little shorter than Rs; cell 1st M_2 closed; m-cu just before the fork of M, more rarely at the fork.

Abdomen relatively long; tergites, including hypopygium, brownish black; basal sternites yellow, the outer segments black. Male hypopygium (Plate 3, fig. 33) with the tergite, *9t*, transverse, the caudal margin gently emarginate. Basistyle, *b*, with the usual ventromesal lobe complex, produced into a large flattened structure, at its base with a smaller lobe that is tipped with several fasciculate setæ. Dorsal dististyle a slender, relatively straight rod; in most specimens longer and more slender than in the paratype figured. Ventral dististyle, *vd*, of moderate size, the rostral prolongation very stout at base; on outer margin before the spines with a small tubercle that is tipped with three or four strong spines, directed outward; rostral spines long and slender, very slightly unequal in length, arising from a low common tubercle; cephalic portion of style near base of prolongation with a group of long setæ. Gonapophyses, *g*, with mesal-apical lobe slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Allotopotype, female. Paratopotypes, several males and females with the types; others at 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

Limonia (*Dicranomyia*) *veternosa* is very distinct from the other described regional species of the subgenus having complex outgrowths of the basistyle and ventral dististyle of the male hypopygium. The group of setæ on the ventral dististyle

near base is suggestive of the otherwise very different *L.* (*D.*) *basiseta* (Alexander), of Japan.

LIMONIA (RHIPIDIA) MONOCTENIA sp. nov. Plate 1, fig. 11; Plate 3, fig. 34.

Belongs to the *uniseriata* group; mesonotal præscutum with three more or less confluent brown stripes, the interspaces golden pollinose; pleura with a black longitudinal stripe; antennæ (male) with eight unipectinate flagellar segments; halteres yellow; femora with the tips black, on the forelegs very broad; wings dark brown, with four very extensive darker brown costal blotches, the remainder of wing disk with small scattered white areas; Sc_1 ending at near one-third the length of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc; m-cu before fork of M; abdominal tergites brownish black; male hypopygium with the rostral prolongation bearing either two or three flattened spines, placed close together at near midlength of the prolongation.

Male.—Length, about 5.5 millimeters; wing, 6.6.

Rostrum and palpi black. Antennæ black, the apical pedicels of the flagellar segments pale; flagellar segments conspicuously unipectinate; longest branches a little shorter than the segments that bear them; basal flagellar segment stout but not distinctly pectinate; flagellar segments two to nine, inclusive, with distinct branches; segments ten and eleven enlarged but not pectinate; terminal segment elongate, exceeding the penultimate. Head brownish gray, the front brighter; anterior vertex narrow, less than the diameter of scape.

Pronotum dark brown. Mesonotal præscutum with three more or less confluent brown stripes, the posterior interspaces and lateral margins golden pollinose, the lateral stripes confluent with the median stripe at anterior ends; posterior sclerites of notum dark brown, the scutellum more pruinose. Pleura brown ventrally, with a conspicuous black longitudinal stripe extending from the cervical region to the base of abdomen, passing beneath the wing root. Halteres pale yellow. Legs with the coxæ brown, the fore coxæ more darkened basally; trochanters light brown; femora yellow basally, the tips black, more extensive on the forelegs where only the bases are narrowly brightened, much narrower on posterior legs, involving only the distal fourth or fifth; tibiæ black; tarsi black, including the posterior pair, much shorter than the tibiæ; claws toothed. Wings (Plate 1, fig. 11) with the ground color rather dark brown, including four even darker costal areas, these much more extensive than the

interspaces; third dark blotch at origin of Rs; remainder of wing membrane variegated by scattered small whitish areas; veins brownish black, the trichia conspicuous. Venation: Sc_1 ending about opposite one-third the length of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc at near two-thirds the length of the cell; free tips of Sc_2 and R_2 both pale, in transverse alignment; m-cu shortly before fork of M; anal veins at origin nearly parallel.

Abdominal tergites brownish black, the basal sternites brighter; ventral lobes of dististyles pale. Male hypopygium (Plate 3, fig. 34) with the caudal border of tergite, *9t*, rather deeply emarginate. Ventral dististyle, *vd*, fleshy, the rostral prolongation relatively long, flattened, bearing two or three spines at near midlength (in the unique type there are three spines on the left style, two on the right); spines sessile, strongly flattened, gently curved, subequal to or shorter than the apex of the prolongation beyond the outermost. Dorsal dististyle suddenly narrowed at apex into a straight spine. Gonapophyses, *g*, with the mesal-apical lobe a straight black point.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 10,800 feet, August 18, 1934 (*Graham*).

Limonia (*Rhipidia*) *monoctenia* is very different from all other regional species of the subgenus in the unipectinate antennæ and pattern of the wings. The only regional member of the group heretofore made known is *L.* (*R.*) *siberica* (Alexander), which has the wing entirely different both in pattern and venation.

ANTOCHA (ANTOCHA) LACTEIBASIS sp. nov. Plate 1, fig. 12; Plate 3, fig. 35.

General coloration of præscutum brownish ocherous, with a median brown stripe; antennæ black throughout; knobs of halteres darkened; legs brown, the terminal tarsal segments passing into black; wings tinged with gray, the prearcular region clear creamy yellow; veins dark brown, very distinct; R_2 and r-m in transverse alignment, both lying far distad, r-m being about one-half the basal section of vein R_{4+5}, cell 1st M_2 about as long as vein M_{1+2} beyond it; m-cu before fork of M; male hypopygium with both dististyles long and slender; outer gonapophyses short, obtuse at tips.

Male.—Length, about 5.5 millimeters; wing, 6.5.

Female.—Length, about 6 millimeters; wing, 6.5.

Rostrum brownish yellow; palpi black. Antennæ black throughout; flagellar segments oval. Head uniformly gray.

Mesonotal præscutum brownish ocherous, with a median brown stripe that is very diffuse, the humeral region brightest; posterior sclerites of mesonotum chiefly dark brown, pruinose. Pleura brownish ocherous, more darkened on the sternopleurite and pleurotergite. Halteres dusky, the knobs darkened. Legs with the forecoxæ darkened, the remaining coxæ and all trochanters pale; remainder of legs brown, the terminal tarsal segments passing into black. Wings (Plate 1, fig. 12) tinged with gray, the prearcular region clear creamy yellow; stigma elongate-oval, darker brown than the ground; veins dark brown, very distinct. Venation: R_2 and r-m in transverse alignment; inner end of cell 1st M_2 somewhat arcuated; basal section of M_3 longer than m; m-cu about one-third its length before the fork of M.

Abdomen dark brown, the hypopygium very little brighter. Male hypopygium (Plate 3, fig. 35) with the tergite, *9t*, narrowly transverse, the caudal margin straight or very slightly produced at near midlength; dorsal surface of sclerite with a transverse discal grouping of setæ. Outer dististyle elongate, slender, gradually narrowed to the acute tip. Inner dististyle subequal in length and nearly as slender, narrowed to the obtuse tip, the surface with abundant setæ. Gonapophyses with the inner pair slender, subtending the ædeagus, each with a second more slender spine nearer base. Outer gonapophyses much shorter, at apex a little dilated into an obtusely rounded, flattened head.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female. Paratopotypes, 1 male, 1 female, altitude 10,800 to 11,000 feet, August 18, 1934 (*Graham*).

The only regional species that is at all similar to the present fly is *Antocha* (*Antocha*) *setigera* Alexander, which has the male hypopygium entirely different in structure.

HEXATOMINI

HEXATOMA (ERIOCERA) ISHIGAKIENSIS sp. nov. Plate 1, fig. 13.

Belongs to the *mesopyrrha* group; head black; mesonotum dull brown, the præscutum with four more reddish brown stripes; legs yellow, the tips of femora, tibiæ, and basal two tarsal segments narrowly blackened; remaining tarsal segments black; wings on costal third intense orange-yellow, the remaining cells weakly infumed, the veins narrowly bordered by yellow; vein Sc_1 angulated and spurred at tip; cell M_1 present; abdomen black, the shield of ovipositor fiery orange.

Female.—Length, about 20 millimeters; wing, 14.5.

Rostrum and palpi black. Antennæ with the scape black; pedicel dark brown; flagellum yellow, the outer segments somewhat darker. Head brownish black.

Mesonotal præscutum dark chocolate-brown, with four more reddish brown, dull stripes, the intermediate pair separated by a capillary pale line and further delimited on their mesal edges by a narrow brown line; scutum reddish; scutellum at base reddish brown, the outer portion more brownish black and pruinose; mediotergite dark brown, with a pale area at each outer posterior corner. Pleura dark reddish brown, including the dorsopleural membrane. Halteres blackened, the base of stem restrictedly pale. Legs with the coxæ and trochanters reddish brown; femora and tibiæ yellow, the tips narrowly but conspicuously blackened; basal two segments of tarsi yellow, the tips narrowly blackened; outer tarsal segments uniformly black. Wings (Plate 1, fig. 13) intense orange-yellow on about the costal third; centers of cells on remainder of wing weakly darkened but veins narrowly bordered by yellow; anal cells and weak streaks in centers of several other cells slightly paler; veins yellow. Macrotrichia of radial veins abundant, of medial veins lacking or virtually so; costa with abundant setæ (female). Venation: Tip of Sc_1 angularly bent into costa, with a spur at the angulation; R_{1+2} about one-half longer than R_{2+3}; cell M_1 present; m-cu before midlength of cell 1st M_2.

Abdomen black, the surface polished, the posterior margins of the segments more opaque velvety. Shield of ovipositor and preceding segment fiery orange; cerci elongate, brownish black on basal half, the outer portion horn yellow.

Habitat.—Japan (Loochoo Islands).

Holotype, female, Ishigaki Island, August 27, 1934 (*Gressitt*).

The present fly is most nearly allied to species such as *Hexatoma* (*Eriocera*) *cæsarea* (Alexander) and *H.* (*E.*) *kelloggi* (Alexander), differing especially in the coloration of the legs and wings. It is now becoming apparent that the males in the species of the so-called *mesopyrrha* group have the costa with very few setæ, whereas in the associated females these are much more numerous and evenly distributed.

HEXATOMA (ERIOCERA) IRIOMOTENSIS sp. nov. Plate 1, fig. 14.

General coloration black, the præscutum with three more-polished black stripes; halteres black; legs yellow, the tips of the

femora and tibiæ narrowly blackened; wings orange-yellow, variegated by dark brown, chiefly as conspicuous seams to the veins, the pattern much as in *sauteriana;* abdomen black, the tergites polished, with velvety-black margins; hypopygium black; shield of ovipositor reddish.

Male.—Length, 11 to 12 millimeters; wing, 8.5 to 10.

Female.—Length, about 21 millimeters; wing, 14.

Rostrum and palpi black. Antennæ with scape and pedicel black; flagellum pale brown; antennæ of male 8-segmented, the flagellar segments gradually decreasing in length to the end. Head velvety black, the vertex and vertical tubercle a little more plumbeous.

Mesonotal præscutum velvety black with three more-polished black to somewhat plumbeous stripes; scutum black, the centers of the lobes more polished; posterior sclerites of notum black. Pleura, including the dorsopleural region, black. Halteres black, the stem a very little paler. Legs with the coxæ and trochanters black; femora yellow, the tips very narrowly black, the amount subequal on all legs; tibiæ yellow, the tips narrowly darkened; basitarsus obscure yellow at proximal end, passing into brown; outer tarsal segments black. Wings (Plate 1, fig. 14) with the ground color deep orange-yellow, conspicuously patterned with dark brown; the dark color appears as relatively narrow seams to the veins beyond the cord, basad of cord forming an oblique cross area in cells R_1, R and M connected with seams along the veins and cord to inclose a large area of the ground in outer ends of cells R and M; cells C and Sc of the ground color; cells Cu and the anals almost uniformly darker, the former invaded near outer end; entire wing apex narrowly margined with dark; veins dark, paler in the flavous portions. Macrotrichia of veins abundant, especially beyond cord. Venation: Sc_2 some distance before tip of Sc_1, just beyond fork of Rs; R_{1+2} about one-half longer than R_{2+3}; m-cu at near midlength of cell 1st M_2; cell M_1 lacking. In the paratype, the right wing shows a curious venational malformation, the basal section of M_{1+2} being misplaced and lying distad of the level of m-cu, thus greatly restricting the area of cell 1st M_2.

Abdomen of male black, with alternate polished and velvety rings; all but distal fourth of each segment polished, more or less nacreous, the apex velvety black; on the outer sternites, the velvety coloration becomes more extensive, involving one-half or more of the segments; hypopygium black. In the female, the

abdomen is more extensively polished black, the genital shield and valves reddish horn-colored.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*). Allotopotype, female, August 25, 1934. Paratopotype, male, August 23, 1934.

This beautiful fly is most nearly allied to the Formosan *Hexatoma* (*Eriocera*) *sauteriana* (Enderlein), which differs conspicuously in the black legs, darkened costal border of wings, and black shield of the ovipositor.

ERIOPTERINI

NEOLIMNOPHILA PERREDUCTA sp. nov. Plate 1, fig. 15.

Mesonotal præscutum gray, with four brown stripes, the intermediate pair darker than the lateral ones; trochanters brownish yellow; wings white, heavily patterned with dark brown; R_2 far before fork of R_{3+4}, the latter vein subequal to vein R_3; cell M_1 small; m-cu close to proximal end of cell 1st M_2.

Female.—Length, 7 to 7.5 millimeters; wing, 7.5 to 8.

Rostrum and palpi black. Antennæ black throughout; fusion segment involving four segments. Head brownish gray.

Mesonotal præscutum gray, with four brown stripes, the intermediate pair more intense, separated by a line of the ground color that is about one-half as wide as either stripe; lateral stripes paler; posterior sclerites of mesonotum gray, the centers of the scutal lobes a little darker. Pleura gray. Halteres pale yellow throughout. Legs with the coxæ dark, pruinose; trochanters brownish yellow; remainder of legs black, the femora brightened at extreme base. Wings (Plate 1, fig. 15) white, the prearcular field more cream-colored; cells C and Sc pale brownish yellow; a heavy brown pattern, including the origin of Rs, anterior cord and stigmal area, together with conspicuous seams on certain of the longitudinal veins, including R_5, M_3, Cu_1, and 2d A; veins pale, darker in the infuscated areas. Venation: cell R_3 very small, with R_2 far before fork of R_{3+4}, the latter vein subequal to R_3 alone; r-m more than one-half its length before fork of Rs; cell M_1 small; cell 1st M_2 elongate, with m-cu close to its proximal end.

Abdomen brownish black.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, female, altitude 10,800 feet, August 18, 1934.

The nearest ally of the present fly is *Neolimnophila picturata* Alexander, which differs especially in the coloration of the thorax, much heavier wing pattern, and details of venation. Both species have r-m connecting with Rs some distance before the fork of the latter.

GYMNASTES (GYMNASTES) OMEICOLA sp. nov. Plate 1, fig. 16.

Allied to *cyanea;* thorax black, the mesonotum with faint bluish reflections; abdomen uniformly black; fore femora brown, the tips narrowly yellow; middle and hind femora yellow, with two black and two yellow rings at and before apex, the actual tip yellow; wings whitish subhyaline, with three brown crossbands, the basal one not conspicuously narrowed behind, darkening the distal third to half of cell 2d A.

Male.—Length, about 4 millimeters; wing, 4.2.

Female.—Length, about 5 millimeters; wing, 4.8 to 5.

Rostrum and palpi black. Antennæ black throughout. Head polished black; anterior vertex very wide.

Prothorax and mesothorax polished black, variegated by the sulphur-yellow dorsopleural membrane; in the female the mesonotum with bluish reflections, not or scarcely apparent in male. Halteres black, the outer ends of knobs conspicuously pale sulphur yellow. Legs with the coxæ and trochanters black; middle and hind femora yellow basally, the enlarged outer ends with two black subterminal rings, the tip and a subterminal ring yellow, the widest of these annuli being the outer dark one; fore femora more uniformly dark brown, the tip narrowly pale; tibiæ light yellow, the tips conspicuously blackened; basitarsi yellow, the tips black; remaining tarsal segments black. Wings (Plate 1, fig. 16) whitish subhyaline, with three brown crossbands, the more basal band broadest, in the type male not or scarcely reaching vein R in front, in the female broader and distinctly reaching costal border, behind involving the distal third or more of cell 2d A; outer dark bands almost exactly as in *cyanea,* the outer pale band a little wider; veins brown. Venation: Almost exactly as in *cyanea.*

Abdomen black, without blue reflections; ovipositor with horn-yellow cerci.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*). Allotopotype, female. Paratopotype, 1 female, altitude 9,000 feet, July 20, 1931 (*Franck*).

The nearest ally of the present fly is undoubtedly the genotype, *Gymnastes* (*Gymnastes*) *cyanea* Edwards (*violacea* Brunetti), of Ceylon and southern India. The present fly is well-distinguished by the almost total lack of blue or violaceous body reflections; the union of the two dark basal fasciæ of *cyanea* into a single broad band that involves the entire outer end of cell 2d A; and the more conspicuous pale yellow tips of the femora.

GYMNASTES (PARAGYMNASTES) MCKEANI sp. nov. Plate 1, fig. 17.

General coloration black; head, antennæ, and legs entirely black; halteres black, with the tips conspicuously white; wings whitish subhyaline, with three broad brown crossbands, the inner edge of apical band ending at vein M_4; R_2 at or close to fork of R_{3+4}.

Male.—Length, about 5.5 to 6 millimeters; wing, 5.5 to 6.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils. Head uniform dull black, gray pruinose.

Thorax entirely black, the surface of præscutum slightly nitidous. Halteres black, the outer half of knob white. Legs black throughout. Wings (Plate 1, fig. 17) whitish subhyaline, with three, broad, complete, dark brown crossbands, the first at level of origin of Rs and tip of vein 2d A, narrower than in *nigripes*, being subequal to or only a trifle wider than the white band beyond it; outer dark bands wide but not as extensive as in *nigripes*, the inner edge of the apical band reaching the posterior margin at vein M_4 instead of vein Cu_1 as is the case in *nigripes;* pale band between the central and outer dark areas relatively broad; a small brown postarcular spot; veins brown, a little paler in the areas. Venation: Cell R_3 unusually large; vein R_4 very long, considerably exceeding Rs; R_2 somewhat variable in position, from at, to a short distance before, fork of R_{3+4} (as figured); m-cu before midlength of cell 1st M_2.

Abdomen black throughout.

Habitat.—Siam (north).

Holotype, male, near Chieng-mai 1928 (*McKean*). Paratopotype, male. Type in the American Museum of Natural History.

Gymnastes (*Paragymnastes*) *mckeani* is named in honor of the collector, Dr. J. W. McKean. The species is closest to *G.* (*P.*) *nigripes* Edwards (Selangor, Perak), differing especially

in the uniform black color of the head and antennæ, and in the distribution of the wing bands.

TEUCHOLABIS (TEUCHOLABIS) IRIOMOTENSIS sp. nov. Plate 1, fig. 18.

Mesonotal præscutum with three confluent polished black stripes; legs black, the bases of fore and middle femora narrowly yellow, the posterior femora entirely black; halteres black throughout; wings subhyaline, the stigma dark brown; veins brownish black; abdominal tergites uniformly black.

Male.—Length, about 6 millimeters; wing, 5.3.

Female.—Length, about 5.5 millimeters; wing, 5.

Rostrum relatively elongate, only a little shorter than the remainder of head, black throughout; palpi black. Antennæ black throughout; flagellar segments short-oval to oval, the verticils longer than the segments. Head black, sparsely pruinose, more heavily so on anterior vertex.

Pronotum darkened above, paling to obscure yellow on sides. Mesonotal præscutum with the humeral region broadly yellow, the remainder of surface chiefly occupied by three confluent black stripes; scutum yellow, the lobes black, the central and lateral portions of the suture remaining pale; scutellum yellow, the parascutella darker; postnotum, including pleurotergite, black. Pleura light yellow, the dorsal anepisternum and ventral sternopleurite a little darkened. Halteres black throughout. Legs with the coxæ and trochanters yellow; femora black, the bases of the fore and middle pair narrowly yellow, including the proximal fourth or thereabouts; posterior femora entirely black; tibiæ and tarsi black. Wings (Plate 1, fig. 18) subhyaline, with a faint brownish tinge, most evident in the outer radial field; stigma subcircular, dark brown; cell Sc weakly infumed; veins brownish black. Costal fringe of moderate length. Venation: m-cu close to fork of M, the cell 1st M_2 elongate, subequal to or longer than vein M_{1+2} beyond it.

Abdomen with the tergites black, the sternites in male chiefly light yellow, variegated on sides by darker; sternal pocket and hypopygium black; abdomen in female black throughout but the dark coloration of sternites probably caused by internal discoloration; genital shield and hypovalvæ black, cerci horn-colored.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*). Allotopotype, female, August 21, 1934.

The nearest ally is *Teucholabis* (*Teucholabis*) *yezoensis* Alexander (northern Japan), which differs most evidently in the orange-yellow knobs of the halteres, the chiefly yellow posterior femora, and the variegated abdominal tergites. The present fly is entirely different from the three species of the subgenus so far discovered in Formosa.

GONOMYIA (PTILOSTENA) LONGIPENNIS sp. nov. Plate 1, fig. 19.

General coloration gray; scape and pedicel whitish, flagellum dark brown; wings tinged with brown, variegated with darker brown and light yellow; vein R_4 strongly recurved; cell 2d M_2 deep; abdominal tergites uniformly dark brown, the sternites light yellow.

Female.—Length, 6.5 to 7 millimeters; wing, 5 to 6.5.

Rostrum and palpi black. Antennæ with the scape and pedicel whitish; flagellum black, the verticils exceeding the segments in length. Head with the front white, the posterior portions of head dark brown, pruinose; posterior orbits slightly pale.

Pronotum and mesonotum dark gray; anterior lateral pretergites yellow; humeral region of præscutum vaguely brightened; pseudosutural foveæ dark brown; scutellum dark reddish castaneous. Pleura with the dorsal portions dark brown, including the dorsopleural membrane, the ventral portions, including the sternopleurite and meron, abruptly pale yellow. Halteres dusky, the knobs dark brown. Legs with the fore coxæ weakly darkened, the remaining coxæ and all trochanters pale yellow; femora yellow; tibiæ and basal two tarsal segments yellow, the tips weakly darkened; remaining tarsal segments black. Wings (Plate 1, fig. 19) tinged with brown, variegated with darker brown and light yellow; cells C and Sc, together with the wing apex, narrowly and abruptly yellow; dark brown areas at arculus, origin of Rs, m-cu, cord, stigma, and as a cloud near outer end of vein 2d A; a distinct paler brown wash in subapical field of wing, involving cells R_3, R_4, R_5, and 2d M_2; veins dark brown, pale in the flavous areas. Venation: Vein R_4 strongly recurved; cell 2d M_2 deep.

Abdominal tergites brownish black; sternites light yellow.

Habitat.—Japan (Loochoo Islands).

Holotype, female, Iriomote Islands, August 24, 1934 (*Gressitt*). Paratopotype, female.

The nearest relative is *Gonomyia* (*Ptilostena*) *teranishii* Alexander (Japan and China), which differs most evidently (in the

female sex) in the broader wings with vein R_4 less recurved and with cell 2d M_2 shallower, and in several details of coloration.

GONOMYIA (GONOMYIA) BIBARBATA sp. nov. Plate 1, fig. 20; Plate 3, fig. 36.

Antennæ dark throughout; cervical region, pronotum, and mesopleura entirely pale yellow, unmarked; mesonotal præscutum and scutum dark brown; scutellum yellow; knobs of halteres darkened; legs dark brown; wings with a faint grayish tinge, the stigma slightly darker; costal fringe long and conspicuous; Sc_1 ending about opposite one-third the length of Rs; m-cu close to fork of M; abdominal tergites uniformly dark brown; sternites yellow; male hypopygium with the gonapophyses symmetrical, each appearing as a slender rod with a recurved spine on outer margin before apex.

Male.—Length, about 3.5 millimeters; wing, 4.4.

Rostrum and palpi dark. Antennæ dark throughout; flagellar segments elongate, the verticils relatively conspicuous. Front yellow; posterior portion of head gray.

Cervical region and pronotum clear light yellow. Mesonotal præscutum and scutum almost uniformly dark brown, the median region of the latter a trifle brightened; scutellum clear yellow; mediotergite dark gray. Pleura and pleurotergite uniformly pale yellow. Halteres pale, the knobs darkened. Legs with the coxæ yellow; trochanters brownish testaceous; remainder of legs dark brown. Wings (Plate 1, fig. 20) with a faint grayish tinge, the stigma slightly darker; veins brownish black. Costal fringe long and conspicuous. Venation: Sc relatively long, Sc_1 extending about to opposite one-third the length of Rs, Sc_2 a short distance from its tip; basal section of R_5 short to very short; m-cu close to fork of M.

Abdominal tergites uniformly dark brown, the sternites pale yellow; hypopygium with the basistyles chiefly pale yellow. Male hypopygium with the basistyles elongate, not produced into conspicuous outer lobes; dististyle single, broken in the unique type. Gonapophyses symmetrical, each appearing as a gently curved blackened rod, before apex on outer margin with a small spine or barb, directed slightly basad.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*).

The structure of the gonapophyses of the male hypopygium is quite different from any other species known to me. The costal fringe, while long, is not as conspicuous as in the allied *Gonomyia* (*Gonomyia*) *longifimbriata* Alexander (Mindanao).

GONOMYIA (GONOMYIA) FOLIACEA sp. nov. Plate 1, fig. 21; Plate 3, fig. 37.

General coloration of mesonotum brownish black, the posterior margin of scutellum yellowish brown; antennæ black throughout; thoracic pleura pruinose with white; knobs of halteres brown; legs obscure yellow; wings with Sc_1 ending nearly opposite midlength of Rs; m-cu some distance beyond fork of M; male hypopygium with the outer dististyle flattened, foliaceous, the tip an acute point, the entire surface with microscopic setulæ.

Male.—Length, about 5.5 millimeters; wing, 6.

Rostrum yellow; palpi black. Antennæ black throughout, the pedicel much enlarged. Head gray, the front and occipital portion more yellowish.

Cervical sclerites and pronotum yellow. Mesonotal præscutum chiefly brownish black, the humeral region lighter brown; scutum black; scutellum black basally, the outer portion paling to dull yellowish brown; mediotergite dark gray. Pleura heavily pruinose with white, the dorsal pleurites and ventral sternopleurite somewhat darker, the white color most evident as a very diffuse longitudinal stripe; dorsopleural membrane yellow. Halteres brown, the base of stem restrictedly pale, the knobs darker brown. Legs with the coxæ and trochanters brownish yellow to obscure yellow, the tarsi darker. Wings (Plate 1, fig. 21) with a faint darker tinge, the stigma pale brown; cells C and Sc somewhat clearer yellow; veins dark brown. Venation: Sc unusually long, Sc_1 ending about opposite midlength of Rs, Sc_2 a short distance from its tip; basal section of R_5 distinct; m-cu nearly half its length beyond the fork of M.

Abdominal tergites uniformly brown, the sternites yellow; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 37) with the outer dististyle, *od*, a flattened leaflike blade that narrows to an acute spinous point, the surface with abundant delicate setulæ; inner style, *id*, with a short basal lobe that bears two fasciculate setæ, additional to the smaller normal setæ; outer branch a narrow blackened rod, the tip very obtuse, near base with a few setæ and one conspicuous spine. Phallosome, *p*, complex, the gonapophyses black, subequal in length but apparently slightly asymmetrical in form.

Habitat.—Formosa.

Holotype, male, Sakahen, altitude 3,000 feet, July 16, 1934 (*Gressitt*).

Gonomyia (*Gonomyia*) *foliacea* is very different from all described regional species in the structure of the male hypopygium, notably the peculiar foliaceous outer dististyle.

ORMOSIA FUGITIVA sp. nov. Plate 1, fig. 22.

General coloration of præscutum pale testaceous, darkened medially; antennæ black throughout; halteres pale yellow throughout; legs obscure yellow, the terminal tarsal segments black; wings with the ground color milky, the stigma and a narrow seam along cord brown; m and M_3 not angulated at point of origin; anal veins strongly convergent.

Female.—Length, about 4.5 to 4.8 millimeters; wing, 5.5 to 5.8. Rostrum and palpi brownish black. Antennæ black throughout; verticils long and conspicuous, much exceeding the segments. Head gray, with yellow setæ.

Mesonotal præscutum pale testaceous, darkened medially; scutum pale; scutellum and mediotergite dark plumbeous brown. Pleura dark plumbeous brown. Halteres pale yellow throughout. Legs with the coxæ dark plumbeous; trochanters obscure yellow; remainder of legs obscure yellow, the terminal tarsal segments black. Wings (Plate 1, fig. 22) with the ground color milky, the stigma brown; narrow but conspicuous brown seams along cord and fork of M_{1+2}, best indicated by darkenings of the otherwise pale veins. Trichia of membrane relatively short and inconspicuous. Venation: R_2 shortly beyond fork of R_{2+3+4}; m and M_3 not angulated at union; m-cu at fork of M; anal veins strongly convergent.

Abdomen dark brown.

Habitat.—China (Szechwan).

Holotype, female, Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*). Paratopotypes, 2 females.

Ormosia fugitiva is allied to *O. diplotergata* Alexander, *O. machidana* Alexander, and *O. takeuchii* Alexander in the pale wings, with vein R_3 not strongly upcurved at outer end and with m and outer section of vein M_3 not angulated at point of union. The species is well distinguished by the coloration of the body and wings, especially the narrow but distinct dark seam along the cord.

ERIOPTERA (PSILOCONOPA) PROPENSA sp. nov. Plate 1, fig. 23; Plate 3, fig. 38.

Allied to *bifurcata;* general coloration gray, the præscutum with three brown stripes; antennæ and legs black throughout; wings narrow, whitish, the stigma barely indicated; male hypopygium with the inner dististyle bifurcate, the apices of the arms nearly smooth; gonapophyses long and slender.

Male.—Length, 5 to 5.5 millimeters; wing, 6.3 to 6.5.

Female.—Length, about 6.5 millimeters; wing, 7.

Rostrum dark gray; palpi black. Antennæ black throughout; flagellar segments short-oval. Head gray, more brownish on disk.

Pronotum dark gray. Mesonotal præscutum gray, with three dark brown stripes, the median stripe in cases more or less split by a paler vitta; posterior sclerites of notum gray, the scutal lobes variegated by brown. Pleura clear gray. Halteres pale yellow. Legs with the coxæ clear gray; remainder of legs black. Wings (Plate 1, fig. 23) much narrower than in *bifurcata,* whitish, the prearcular region more yellow; stigma barely indicated by a brownish wash; veins dark brown. Venation as in *bifurcata,* but cells narrower due to the shape of wing, the differences especially noticeable in the anal field.

Abdominal tergites brownish medially, paling to gray on sides; sternites clearer gray; a series of linear blackish impressions along pleura. Male hypopygium (Plate 3, fig. 38) with the outer dististyle, *od,* a simple rod, the apex narrowed and blackened. Inner dististyle, *id,* bifurcate, the apices of both arms smooth or with scattered coarse denticles only. Gonapophyses much longer and more slender than in *bifurcata.*

Habitat.—China (Szechwan).

Holotype, male, Chengtu, altitude 1,700 feet, November 1, 1932, to March, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 4 of both sexes, November 1, 1932, to May 10 to 14, 1933 (*Graham*).

The nearest ally is *Erioptera* (*Psiloconopa*) *bifurcata* Alexander (Japan), which is readily told by the broader wings and slight differences in the structure of the male hypopygium, notably of the gonapophyses. I doubt very much whether the subgenus *Ilisia* Rondani can be maintained as distinct from *Psiloconopa* Zetterstedt.

MOLOPHILUS INIMICUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 39.

Belongs to the *gracilis* group and subgroup; general coloration of mesonotum grayish brown, the pleura darker; halteres uniformly light yellow; wings tinged with brownish gray, the stigma and vague clouds on cord slightly darker; anal veins elongate, converging apically; male hypopygium with all lobes of basistyle fleshy and obtuse at tips; ventral lobe with retrorse blackened spines; outer dististyle at apex dilated into a bispinous

scabrous head; inner dististyle an arcuated black rod, strongly bent at near midlength, with about four strong spines on concave face.

Male.—Length, about 4.3 millimeters; wing, 5.

Rostrum dark brown; palpi black. Antennæ of moderate length, if bent backward extending about to root of halteres, brown throughout; flagellar segments oval to long-oval, the verticils of the basal segments elongate. Head chiefly brown.

Mesonotal præscutum brown, more or less pruinose; anterior lateral pretergites light yellow; scutum and scutellum obscured in the type; mediotergite dark gray. Pleura and sternum brownish black. Halteres uniformly light yellow throughout. Legs with the coxæ and trochanters dark brown; femora obscure brownish yellow, the tips narrowly brighter; tibiæ brown; tarsi black. Wings (Plate 1, fig. 24) with a brownish gray tinge, the stigmal region and vague clouds on anterior and posterior cords weakly darker; prearcular and costal regions clearer yellow; veins brownish yellow; macrotrichia dark brown. Venation: R_2 lying shortly distad of level of r-m; m-cu sinuous, about one-half the petiole of cell M_1; anal veins elongate, convergent apically, narrowing cell 1st A before outer end.

Abdomen dark brown, the hypopygium a little brighter, brownish yellow. Male hypopygium (Plate 3, fig. 39) with all three lobes of basistyle blunt at tips, the dorsal lobe more slender, with pale setæ only; mesal lobe, *mb*, gently curved, with long black spines; ventral lobe, *vb*, broad, with about sixteen to eighteen retrorse black spines. Outer dististyle, *od*, a slender black rod, the apex dilated into a bispinous head, the surface surrounding these spines with microscopic scabrous points. Inner dististyle, *id*, a little longer, appearing as a relatively slender black rod that is bent almost at a right angle, narrowed to an acute point, the base with a few small pale tubercles, each tipped with a weak seta; bend of style on concave face with about four strong black spines.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 10,800 feet, August 18, 1934 (*Graham*).

Molophilus inimicus is very different from the other regional species of the genus. It is most generally similar to *M. crassulus* Alexander, but all details of the hypopygium are quite distinct.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *mb*, mesal lobe of basistyle; *od*, outer dististyle; *p*, phallosome; *s*, sternites; *t*, tergites; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

Plate 1

FIG. 1. *Ptychoptera clitellaria* sp. nov., venation.
2. *Paracladura omeiensis* sp. nov., venation.
3. *Tipula (Formotipula) unirubra* sp. nov., venation.
4. *Nephrotoma biarmigera* sp. nov., venation.
5. *Nephrotoma evittata* sp. nov., venation.
6. *Nephrotoma caudifera* sp. nov., venation.
7. *Nephrotoma nigrostylata* sp. nov., venation.
8. *Phalacrocera minuticornis* sp. nov., venation.
9. *Limonia (Limonia) prudentia* sp. nov., venation.
10. *Limonia (Dicranomyia) veternosa* sp. nov., venation.
11. *Limonia (Rhipidia) monoctenia* sp. nov., venation.
12. *Antocha (Antocha) lacteibasis* sp. nov., venation.
13. *Hexatoma (Eriocera) ishigakiensis* sp. nov., venation.
14. *Hexatoma (Eriocera) iriomotensis* sp. nov., venation.
15. *Neolimnophila perreducta* sp. nov., venation.
16. *Gymnastes (Gymnastes) omeicola* sp. nov., venation.
17. *Gymnastes (Paragymnastes) mckeani* sp. nov., venation.
18. *Teucholabis (Teucholabis) iriomotensis* sp. nov., venation.
19. *Gonomyia (Ptilostena) longipennis* sp. nov., venation.
20. *Gonomyia (Gonomyia) bibarbata* sp. nov., venation.
21. *Gonomyia (Gonomyia) foliacea* sp. nov., venation.
22. *Ormosia fugitiva* sp. nov., venation.
23. *Erioptera (Psiloconopa) propensa* sp. nov., venation.
24. *Molophilus inimicus* sp. nov., venation.

Plate 2

FIG. 25. *Tipula (Formotipula) unirubra* sp. nov., male hypopygium, details.
26. *Nephrotoma biarmigera* sp. nov., male hypopygium, details.
27. *Nephrotoma evittata* sp. nov., male hypopygium, details.
28. *Nephrotoma definita* sp. nov., male hypopygium, details.
29. *Nephrotoma caudifera* sp. nov., male hypopygium, ninth tergite.
30. *Nephrotoma caudifera* sp. nov., male hypopygium, details.
31. *Nephrotoma nigrostylata* sp. nov., male hypopygium, details.

Plate 3

FIG. 32. *Limonia (Limonia) prudentia* sp. nov., male hypopygium.
33. *Limonia (Dicranomyia) veternosa* sp. nov., male hypopygium.
34. *Limonia (Rhipidia) monoctenia* sp. nov., male hypopygium.
35. *Antocha (Antocha) lacteibasis* sp. nov., male hypopygium.
36. *Gonomyia (Gonomyia) bibarbata* sp. nov., male hypopygium, gonapophysis.
37. *Gonomyia (Gonomyia) foliacea* sp. nov., male hypopygium.
38. *Erioptera (Psiloconopa) propensa* sp. nov., male hypopygium.
39. *Molophilus inimicus* sp. nov., male hypopygium.

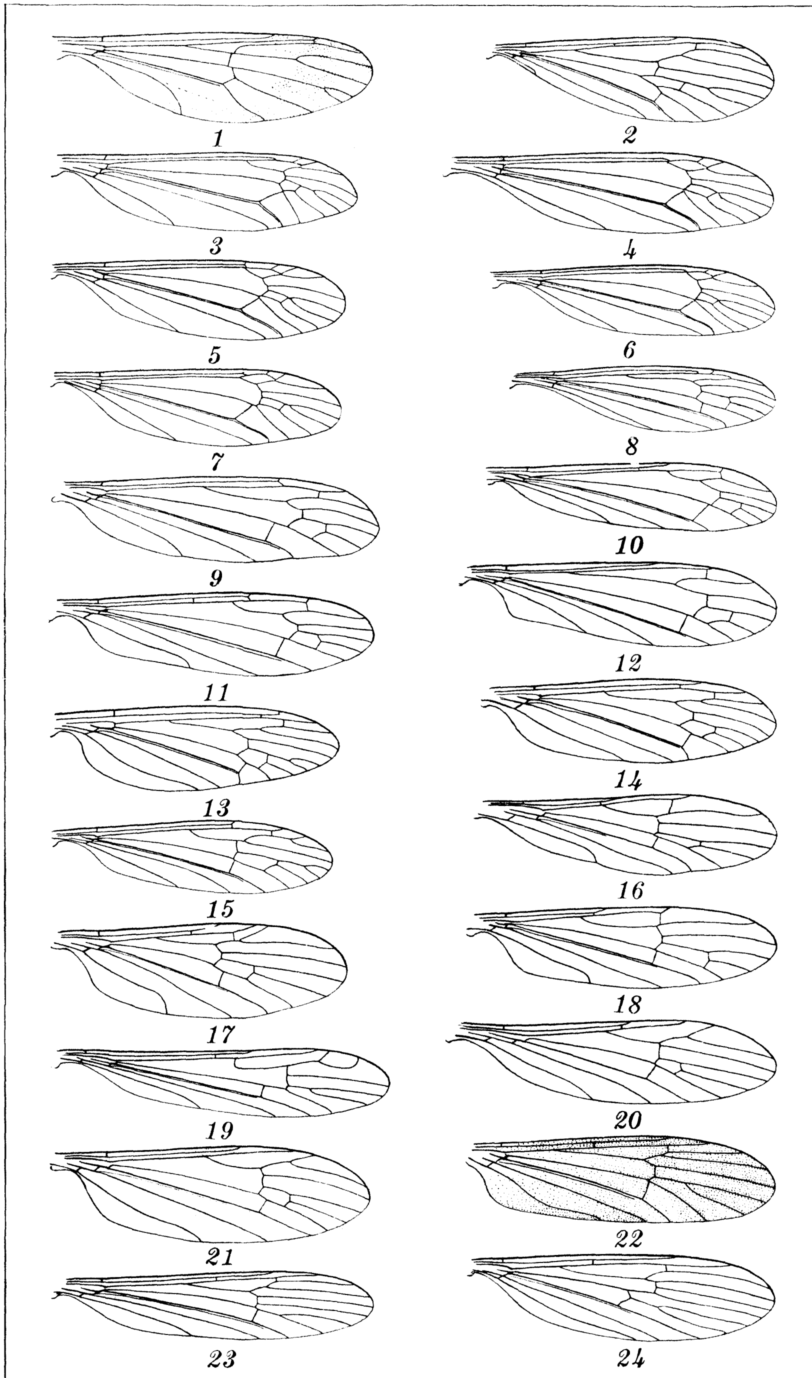

PLATE 1.

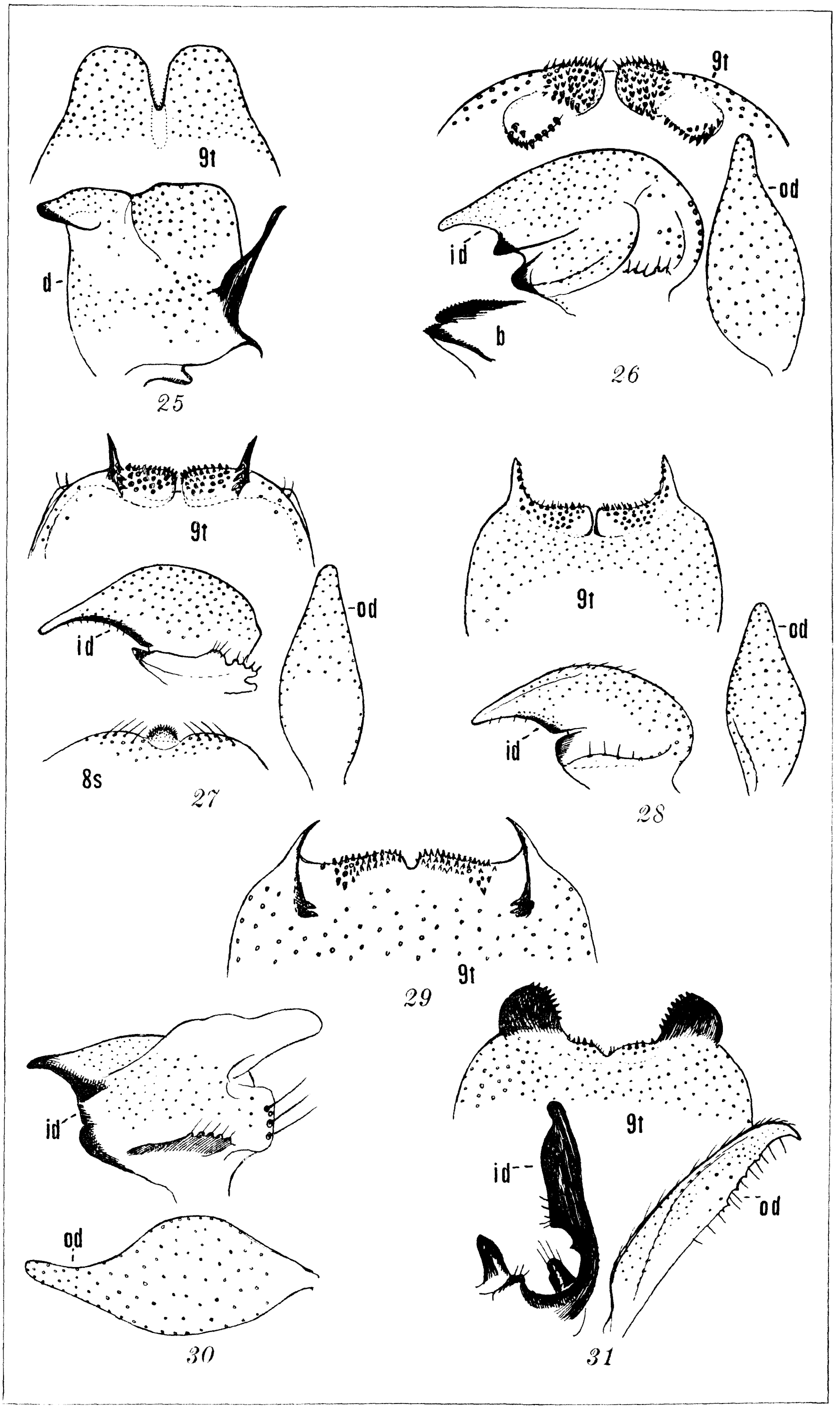
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PLATE 2.

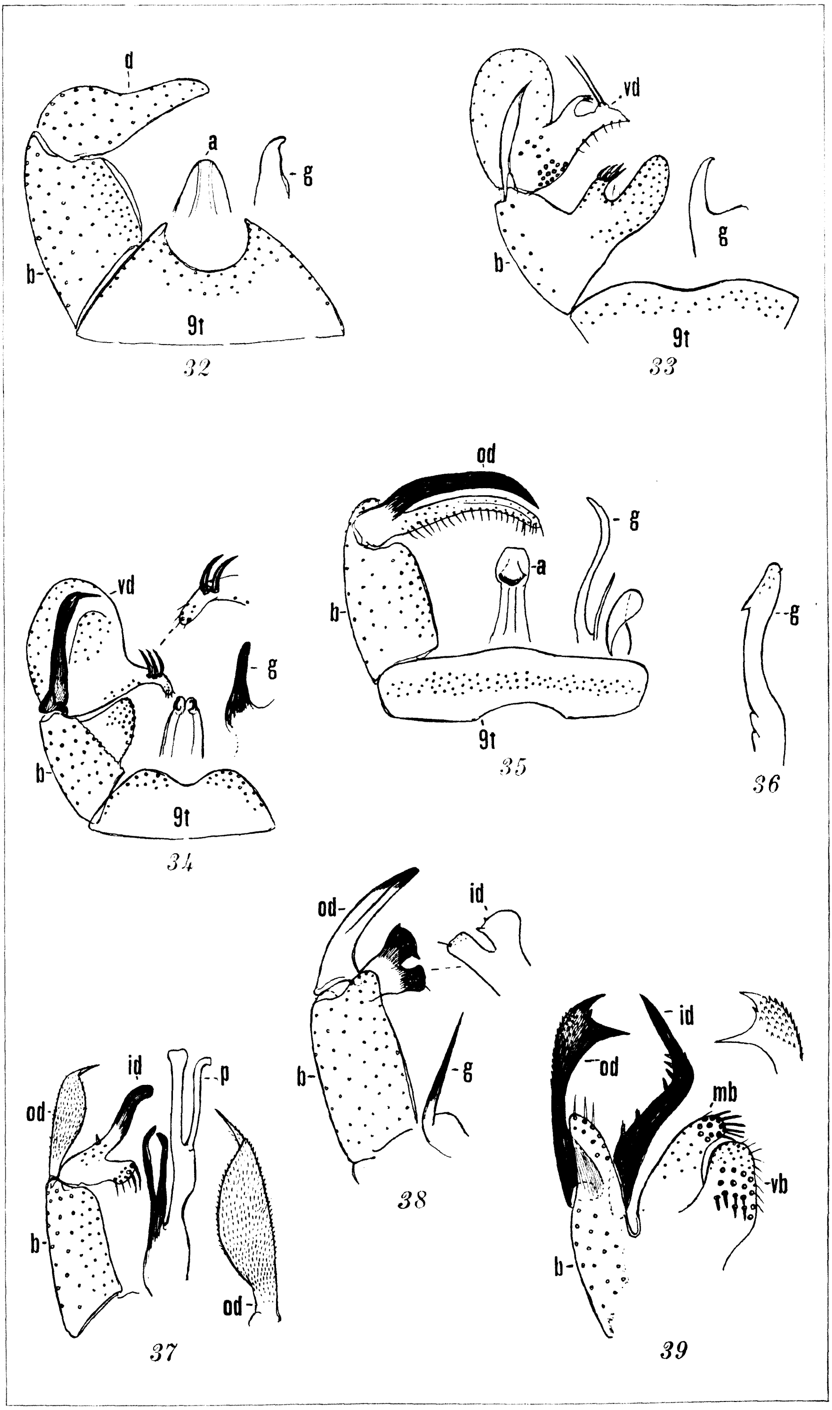
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PLATE 3.

GEOLOGY OF THE WHITE-CLAY DEPOSITS IN SIRUMA PENINSULA, CAMARINES SUR, LUZON

By QUIRICO A. ABADILLA
Chief, Division of Mines, Bureau of Science, Manila

ONE PLATE

INTRODUCTION

White clay has been used for a long time in several isolated localities in Camarines Sur, Luzon, for whitewashing houses, but its occurrence in Siruma Peninsula had not been reported to the Bureau of Science until the beginning of the hectic mining boom of 1933. Mr. Abarquez was sent out to confirm this report, and in May, 1933, after a three-day reconnaisance, he found a deposit in Sitio Napu, which he estimated to contain about 1,000 tons of white clay. Tests made by the ceramic laboratory of the Bureau of Science showed that this clay was the most refractory of all the local materials submitted so far to the Bureau of Science, that it could be put easily in suspension and was well adapted for casting such objects as bowls, saucers, and floor tiles, that it could well be used as a substitute for imported fire bricks, and that it might prove to be a good material for the manufacture of various other articles that are being imported into the Philippines to the amount of hundreds of thousands of pesos every year.

On the strength of these results, a recommendation was made to His Excellency, the Governor-General of the Philippine Islands, to reserve the Siruma clay deposit in order to avoid the harmful effects of speculative manipulation of the source of raw material for a ceramic industry in the Philippines. Accordingly Proclamation No. 583 was issued by the Governor-General January 5, 1935, reserving "All that area bounded by north latitudes 13 degrees 55 minutes 30 seconds, and 14 degrees 2 minutes 30 seconds and by east longitudes 123 degrees 15 minutes 45 seconds and 123 degrees 20 minutes 00 seconds." This reservation includes most of the valuable clay deposits, but it would be desirable to move the eastern boundary about one kilometer to include the Sulpa clay deposit.

In order to secure further data on the geology of the Siruma clay, the writer made a reconnaisance of Siruma Peninsula, from April 24 to 30, 1934, inclusive. He obtained his field notes and located them through the use of traverse lines, which he ran along the coast of Sapenitan Bay, Butauanan Bay, and Butauanan Island, along the trail from Tandoc to San Vicente, thence to Sulpa, and from San Vicente to Siruma, Suguitan, Sulpo, and Cabuyuan. These traverse lines were controlled by pace and Brunton compass and adjusted to the Coast and Geodetic Survey map, which was used as a base. A few details obtained from the map of the Cadwallader Gibson Lumber Co. were incorporated.

LOCATION AND ACCESSIBILITY

Siruma Peninsula is the northwest end of Caramoan Peninsula from which it is almost entirely separated by Looc River and San Vicente Bay. It is located on the east side of the mouth of San Miguel Bay and may be reached from Manila by the Manila Railroad as far as Naga, thence by automobile or bus as far as either Calabanga or Manguirin, from which small motor boats and launches make more or less regular trips to Siruma, Tandoc, San Vicente, and some other barrios, depending on the cargo and passengers available.

The trip from either Calabanga or Manguirin to Siruma Peninsula should not take over three hours by water, but since the launches stop in many small places to collect cargo and passengers, it sometimes takes more than twenty-four hours to cover the distance.

CULTURE

In Siruma Peninsula there are no roads but there are a few open foot trails and several kilometers of railroad tracks belonging to the Cadwallader Gibson Lumber Co. These tracks are being extended to cover the company's lumber concession in Siruma Peninsula.

Siruma is the only municipality in Siruma Peninsula, but Tandoc, being the site of the sawmill of the Cadwallader Gibson Lumber Co., is the most important sitio. It has a labor population of over 1,000 people, living in a camp, or small village, built by the company along the southwestern shore of Butauanan Bay.

At the end of the railway in Tandoc a wooden pier has been built to accommodate ocean-going steamships, which carry lumber to the United States.

TOPOGRAPHY AND VEGETATION

Siruma Peninsula is covered with rolling hills separated by narrow valleys in the central part of the peninsula and by open and swampy ones near the coast. The highest hill or mountain is about 70 meters high, and the average relief is about 30 meters. The coast is deeply indented by shallow bays and sharply protruding and narrow peninsulas. It may be inferred from the outline of the coast and the occurrence of sunken valleys like that of Looc River, San Vicente Bay, and the upper portion or head of Butauanan Bay that this peninsula has recently submerged.

Near the northern and western coasts the hills are generally covered with cogon grass on their flanks, and capped with forest. In the central part of the peninsula the hills are thickly covered with virgin forest which is the source of lumber supply of the Cadwallader Gibson Lumber Co. Most of the coast is bordered with mangrove near the river mouths and with white sandy beach between them.

GEOLOGY

The country rock in Siruma Peninsula is andesitic basalt in different stages of schistosity. The trend of the schistosity varies in different places and is generally at right angle to the coast line. In the greater portion of the peninsula the original rock cannot be distinguished, partly due to its complete metamorphism into schist, and partly due to weathering. Due to the latter the hills have been rounded by erosion and from a distance the topography resembles that of a shale country.

Along the creeks and trails numerous floats of white and coarsely crystalline barren quartz occur. They look more like cavity fillings or lenses than like vein material.

Along the railroad tracks in Siruma Peninsula zones of light-colored schist that alters into white clay occur. These zones are narrow and of limited extent, but rather frequent and are probably the source of the clay deposits that have accumulated in the valleys.

In Suguitan and Cadangan Creeks, near San Vicente, there are outcrops of white crystalline limestone, which is generally green on the surface due to a thin moss growth. This limestone is confined along the channels and banks of the creeks and is probably the inland extension of the coquina beds, which are in the course of formation along the coasts of Siruma Peninsula.

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Long stretches of such coquina beds may be seen, particularly along those portions of the coast of Butauanan Bay and Butauanan Island that are not exposed to strong wave action. These beds dip about 5° toward the sea, and their strike is parallel to the contour of the coast.

WHITE CLAY

Four places are now definitely known where white-clay deposits of probable commercial size occur; Napu, Suguitan, Cabuyuan, and Sulpo. They may be briefly described as follows:

The Napu clay deposit.—This deposit was visited by Mr. Ramon Abarquez in May, 1933. It consists of several small deposits located along a tributary to Bahao Creek, about one hour's walk southeast of the town of Siruma (4.68 kilometers south 56 east, to be exact). Several pits have been dug in this place, which showed a deposit of white clay covered with an overburden of reddish ferruginous soil. The white clay becomes mottled with depth. It may amount to over 1,000 tons at least, according to Mr. Abarquez's preliminary calculations.

The Suguitan clay deposit.—The deposit in Suguitan is located on the banks of Suguitan Creek, about 1 kilometer southwest of the barrio of San Vicente. The clay is white to slightly gray and plastic and contains varying amounts of fine quartz sand. The deposit from which our sample was taken is evidently alluvial and has been washed down from the nearby hills. The mud that has been smeared over the bushes and grass by the carabaos whitens on drying, suggesting that it is of the same nature as the clay found down the creek. This fact leads us to presume that the clay deposit may extend to the hills, where the carabao mud holes are located.

The Cabuyuan clay deposit.—In Cabuyuan Creek the clay deposit is found along the banks, about 200 meters from Bahao River, into which the creek flows, and about 3 kilometers west of San Vicente, near the railroad track of the Cadwallader Gibson Co. This locality is low and is frequently flooded, the average elevation being barely 5 meters above the creek. The deposit may have a lateral extension of 300 meters square covering both sides of Cabuyuan Creek.

The clay is from white to slightly gray, highly plastic, and contains a small proportion of fine white sand. The plasticity seems to decrease with the amount of sand.

The Sulpo clay deposit.—The Sulpo deposit is located about 1.5 kilometers north-northeast of San Vicente along the banks of Sulpo Creek and near the trail to Diniagan. It is in a flat country with an elevation of about 6 to 10 meters above the creek and covers an area about half a kilometer square. Our sample was obtained from pits that were dug at the bank of the creek by people who used the clay for whitewashing their houses. The deposit is an alluvial mantle covered with a loam overburden 50 to 100 centimeters thick.

The Sulpa clay deposit.—The deposit in Sulpa is located about 2 kilometers north-northeast of the Sitio of Sulpa. It is a small deposit that has been washed down from the hills and has accumulated in the valley of Mayboclod Creek, a small and narrow valley that may be reached by way of an overgrown foot trail. This clay deposit is probably of limited extent as shown by the fact that only outcrops of solid schist occur on the hill sides and along the creeks and trails. The clay is whiter than that found in Suguitan, Sulpo, and Cabuyuan Creeks, and contains fine quartz sand, which makes it gritty.

COST OF MINING AND TRANSPORTATION

The cost of digging the clay samples that we brought to Manila was 2 pesos per sack of an average weight of 93 kilos, placed in San Vicente. The freight on the Manila Railroad to the Tutuban station was 3.85 pesos for a lot of six sacks, or 64 centavos per sack. To this must be added the cost of two gunny sacks, 30 centavos, the transfer from San Vicente to Naga, 79 centavos, and truckage in Manila, 76 centavos per sack, bringing the total cost of placing a sack of 93 kilos in Manila to 4.49 pesos. Two gunny sacks were necessary to hold the clay as they rotted quickly due to the moisture of the clay and could not stand its weight.

If every item in this estimate were proportional to the weight of the clay, 1 metric ton of it would cost about 48.30 pesos delivered in Manila. However, this figure is based on the mining and transportation of a lot of six sacks, the transfer of which between San Vicente and Naga was very expensive due to the very irregular route over which the clay was carried by carabao-drawn sled from the clay deposits to the canoe landing in San Vicente, by canoe to the head of Looc Bay, by launch to Kalabanga, and by truck to Naga station. It can be seen, therefore,

that there is room for simplifying the transportation and reducing its cost. For instance, it probably would be much cheaper to transport the clay in large lots directly by water on chartered freighters or sailboats from Siruma to Manila. There is also the possibility of reducing the cost of mining, which in the case of the Siruma clay amounts to mere digging, to within 1 peso per ton. By reducing mining and transportation costs, it may be possible to reduce the cost of 48.30 pesos, which we have obtained above, to less than 15 pesos.

CONCLUSION

The clay deposits in Siruma, as stated above, are of alluvial origin and of mantle form. That the deposit may extend in depth below the level of the creeks or even below sea level in some locality is possible, as there may have been deposition of clay before the recent subsidence of Siruma Peninsula. The possibility of clay in Siruma is that of many small deposits scattered over a wide area. While their areal extent and depth are not fully determined, it is very probable that an aggregate of at least 15,000 tons of clay may be available from the different deposits which are known at present.

Actual development work by digging exploratory pits and trenches or boring holes with auger or post-hole diggers at the Napu, Suguitan, Sulpu, and Cabuyuan deposits will have to be made to arrive at definite figures. For this work an outlay of 5,000 pesos should be sufficient, excluding the salary of a supervising engineer.

ILLUSTRATION

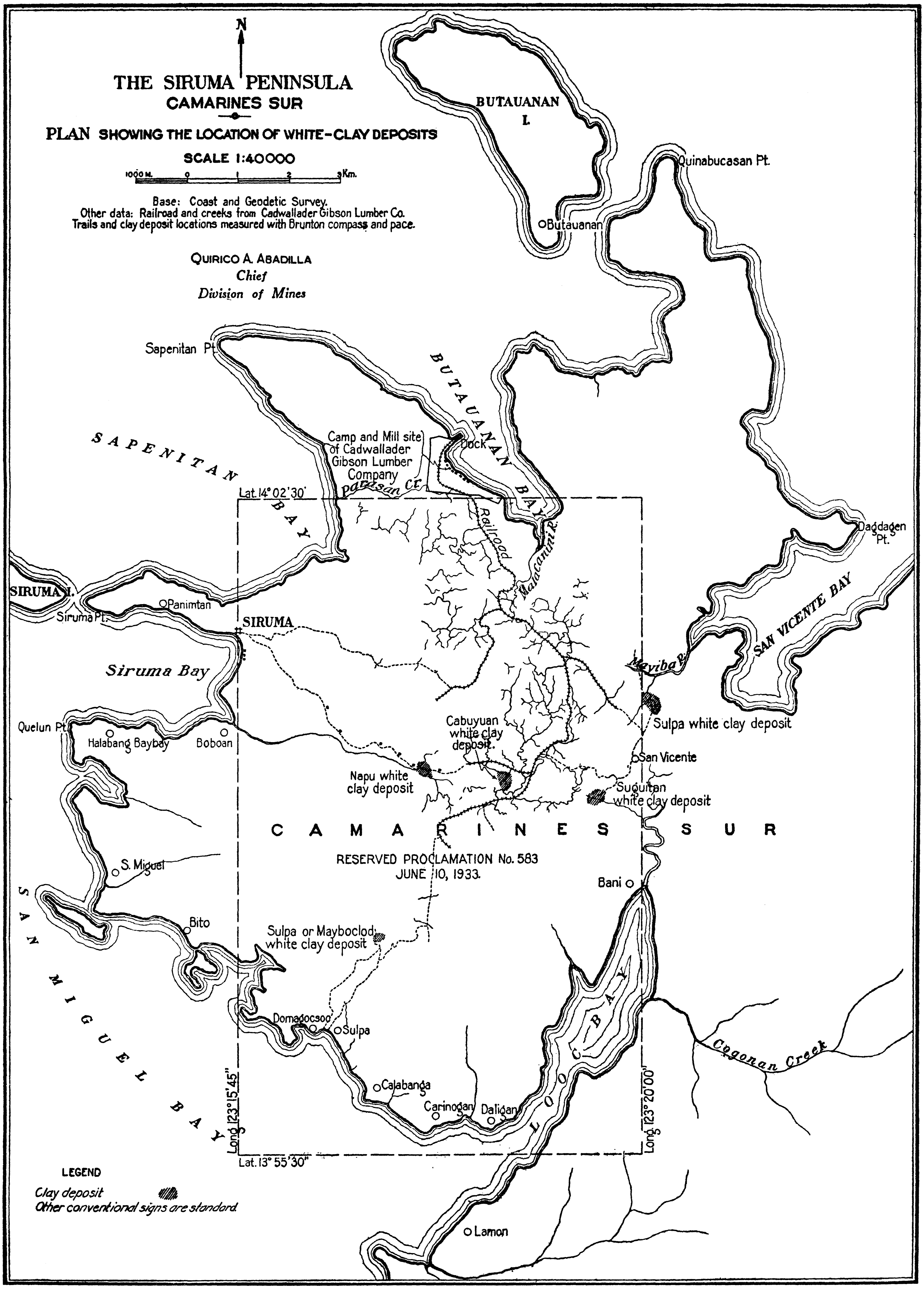

PLATE 1. SIRUMA PENINSULA, LUZON, SHOWING THE LOCATION OF WHITE-CLAY DEPOSITS.

THE DUMAGATS OF FAMY

By GENEROSO S. MACEDA

Of the National Museum Division, Bureau of Science, Manila

FIVE PLATES

INTRODUCTION

Investigations conducted by many authorities on the Philippine people have shown that the present civilized peoples of the Philippines, those now called Filipinos, are not really native to the Islands. The ancestors of the present Filipinos came from across the seas and settled in the Islands. These ancestors were in a rather high stage of civilization, and found in their new home an aboriginal people in the lowest stage of culture.[1] Naturally, the new-comers had the upper hand, and upon making their homes drove the aborigines from the shores and rivers that had been their homes into the interior.[2]

Hundreds of years elapsed, during which the Chinese came in junks and traded occasionally with the new-comers.[3] In 1521 the Spaniards discovered the Philippines and claimed them in the name of the King of Spain. The civilization they found had already risen to a comparatively high stage. The Malays had brought with them the art of writing from across the sea, and now had written records and documents. The missionaries, however, in their excessive zeal to implant the Christian faith among them, destroyed such writings as traces of paganism.[4]

As time passed, the aborigines were driven into the mountains by the growing population of the new-comers thriving under Spanish rule and culture. From that time to the present, these aborigines have dwelt in the mountains or along desolate

[1] Barrows, David P., History of the Philippines 7–11.

[2] Fernandez, L. H., A Brief History of the Philippines 2.

[3] Fernandez, L. H., op. cit. 89–90; Craig, Austin, The Former Philippines Thru Foreign Eyes 144–145; Barrows, David P., op. cit. 33.

[4] Craig and Benitez, Philippine Progress Prior to 1898, 77.

seashores, hardly getting in touch with the civilized people of the lowlands except for trading purposes, and barely rising from their primitive culture. They are scattered all over the Islands in the Cordilleras, Sierra Madre Range, and in some portions of the mountains of the southern islands. They live mostly by hunting and fishing. Those living near civilized people are gradually absorbing civilization; some of them are at present discarding their loin cloth for trousers, and beginning to wear undershirts to clothe the upper portion of the body. Some have even gone as far as to use matches from the towns in the lowlands. The Dumagats treated in this paper form one group of these aborigines.

GEOGRAPHIC DISTRIBUTION OF THE DUMAGATS

The Dumagats include but a very few of the non-Christian tribes in Luzon, each group being made up of only a few families.

They are widely distributed in the part of the Sierra Madre Mountains (Plate 5) near the small town of Famy, in Laguna Province. The rest of their kin are scattered there and in the mountains of Santa Maria (also a part of the Sierra Madre Mountains), Baler, Polillo, Mauban, and in Nueva Vizcaya Province.

Some of them are also located in the Kalawat Islands, and other small islands off the northern coast of Camarines.[5]

At present, the steady movement of the Dumagats is toward Nueva Vizcaya Province on account of the homesteaders, who are slowly driving them away from the regions they now inhabit. One word, however, must be said pertinent to this statement. It must not be inferred that the Dumagats are a nomadic people in the strict sense of the word.

> The Dumagat is not a true nomad but moves about, having more or less fixed camping places within a somewhat restricted area to which he claims ownership . . .[6]

If we attempt to investigate thoroughly the places mentioned and quoted in the preceding paragraph we will not find these people in large numbers, for seldom do they stay very long in a place.

[5] Beyer, H. O., Population of the Philippines in 1916. Philippine Education Co., Manila (1917) 42.

[6] Turnbull, W., The Dumagats of northeast Luzon, Philippine Magazine, Philippine Education Co., Manila (August, 1929) 131.

THE TOWN OF FAMY

A quaint, curious little community is the town of Famy, situated near the northeasternmost limits of Laguna Province (Plate 5), bordered on practically all sides by huge mountains of the Sierra Madre Range. Beyond the mountains northward lies the neighboring town of Santa Maria, which is the most remote municipality of the province in that direction. It is not very easy to traverse the distance between the two towns, in spite of their proximity, for the topography prevents the construction of a straight road. Hence, all transportation has to be circuitous. Eastward on the other hand, lie the mountains that separate Laguna from the adjacent Province of Tayabas. Only foot trails, well-known to the sturdy mountaineers, connect the two provinces with one another; sometimes travelers less versed in the geography of the country are obliged to hew their way through the forests in order to reach the seacoast of Tayabas.

As shown on the map Famy can be reached only over an unimproved road. The forking of the road is at the town of Siniloan, which lies south of Famy; consequently one traveling from Famy to Santa Maria has to go south to Siniloan and enter the main thoroughfare in the northwest direction up to the town of Mabitac before finally turning northward to reach Santa Maria. There is no direct road connecting Famy and Santa Maria because of the highlands between the two towns. However, there are foot trails, which are known only to sturdy mountaineers. For this reason planters are just beginning to take an active interest in the vicinity of this town and to cultivate its fertile soil for coconuts. Patches of coconut trees and numerous *kaiñgins*, or clearings, where camotes and other similar crops are planted, may be seen now rising from the place.

The very location of Famy, then, is not conducive to progress. Although all other *baybay* towns[7] have made remarkable advances both in wealth and in culture, Famy lags behind, handicapped by the limited access to traders.

[7] The "baybay towns" are those municipalities bordering the eastern shore of Laguna de Bay, the name *baybay* meaning "coast or shore." Hence, shore towns. Famy is still called a *baybay* town though it is rather too far inland to be termed one.

The municipality is not populous. A census [8] of the inhabitants reveals that the town and all its outlying barrios have a general population of only 1,095. Of these, 535 are males and 560 females. Within the confines of the town—that is, excluding the barrios—the population runs down to 965, of which 464 are males and 501 are females. The remaining 130 people living in the barrios are still apportioned among five districts, which are subdivided into still smaller parts. The numerous barrios are indicated in Table 1.[9] Each district is a unit represented by a Teniente del Barrio.

TABLE 1.—*The districts and their outstanding barrios.*

District No. 1:
- Panagarawan.
- Lucong.
- Talaga (sitio).
- Calumpang.
- Batuhan.
- Buhay.
- Palacio.

District No. 2:
- Llabac.
- Suncasuncahan (sitio).
- Kapatalan.
- Naga.
- Mayatba.
- Isabela (sitio).
- Daan Corte (sitio).
- Salang Bato.

District No. 3.
- May-init.
- De Castro.
- Pagkakabitan.
- Dapi.
- Malaking Bundok (sitio).
- Bulihan.
- Parusa.
- Palo (sitio).

District No. 4:
- Cuevang Bato.
- Lilian.
- Paritulot.
- Kulong.
- Tucorlangit.
- Balitoc.
- Daan Carga.
- Dorongawan (sitio).
- Sahor-olan.

District No. 5:
- Malico.
- Maate.
- Bacong.
- Minayutan.
- Katay-puanan.
- Sapang Pilaway.
- Cortadilla.
- Timbugan (sitio).

The Tagalog names of the barrios are derived either from the chief characteristic of the place or from an event that has happened there. *Talaga,* for instance, suggest the presence of some wells in the barrio; *Calumpang,* the presence of a calumpang tree; *Batuhan,* that the region is rocky; *Suncasuncahan,* that the ground is filled with hollows; *Dapi,* that there is a kind of soft stone in the barrio; *Parusa,* that somebody was tortured there; *Cuevang Bato,* that there is a stone cave in the place;

[8] The Philippine Census, Bureau of Printing, Manila 2 (1918) 173, Table 4.

[9] Municipal records of Famy.

Kulong, that the barrio is cut off from others by natural barriers; *Dorongawan*, that the place commands a lofty view of the surrounding barrios; *Sahor-olan*, that the place is hollow and is filled with water whenever it rains.

ORIGIN OF THE TERM DUMAGAT

The people now designated by the name Dumagat formerly dwelt along the shores of the Pacific Ocean, the chief source of their subsistence naturally being the sea. Hence, they earned the name Dumagats, which translated into English, literally means "Sea People"—a term also signifying their dependence on marine products. When interviewed, a number of them said: "We call ourselves Dumagats, or 'mga taga tabing dagat'—the people living near the seashore." They came from across the sea and upon landing on the coast made their homes there.

An intimate account of the life of the least known group of the people in the Islands—the Dumagats, the Sea People of the Northeastern coast of Luzon, believed to have come originally from New Guinea.[10]

PHYSICAL CHARACTERISTICS

The Dumagats are of mixed blood; hence, they bear a close resemblance to the Aetas, a resemblance so close that their Christian neighbors are prone to designate them with the same name, by mistake. A more-detailed study of their physical characteristics, however, will reveal many important differences from the Aetas.

Physical type essentially Indonesian but nearly all individuals show marked Papuan characteristics.[11]

The Dumagats possess a dark skin, curly or very kinky hair in many instances, thick lips, and markedly flat noses. In stature they do not belong to the type that may be called short. The height of the male Dumagat of Famy varies from 4 feet 11 inches to 5 feet 6 inches. The females on the other hand vary in height from 4 feet 5 inches to 5 feet 3 inches. These people as a whole are fairly strong. In particular, they have very strongly developed thighs, by reason of the kind of life they lead.

In their everyday life they are industrious, lively, cheerful, superstitious, brave, kind, friendly, trustworthy, possess much

[10] Turnbull, W., op. cit. 132. [11] Beyer, H. O., loc. cit.

endurance to pain, and are honest in their dealings among themselves, with regard to the settlement of questions of land boundaries and property rights.

> However, they are mentally and physically superior to the Aeta, whatever their ethnologic status may be.[12]

One of their outstanding qualities, which make them lovable, is their unrevengefulness and spirit of fair play. They will not strike at a person behind his back—unlike the Aetas, most of whom are sly and treacherous.

CLOTHING

The clothing of the men is very simple and primitive, consisting of a single loin cloth. The women, for their part, wear the tapis, a sheet of cloth wound about the body and fastened a little above the breasts. The cloth falls to a little below the knees. Both the loin cloth and the tapis are of native-grown cotton. Very often they are dyed bright red, for these people love red. Sometimes the men wear short cloth jackets.

At present, however, the Dumagats are undergoing a change in their mode of dress. The men are slowly learning to wear regular trousers and undershirts, while the women are beginning to wear sayas or skirts. This change can be explained by their more frequent contact with their Christian neighbors.

ORNAMENTS AND BODILY DECORATION

The Dumagats love to adorn their bodies in various ways. The most characteristic adornments of the men are bejuco rings encircling the arms, waist, and head. In their liking for gaudy show they stain their bejuco rings red.

> A red belt of stained rattan is used by men and women. Both sexes use wristlets and the males armlets . . . The Dumagat's love of bright-colored adornment is not confined to any age. It begins with the small children who deck themselves out with colored berries and flowers, and is as intense in the old who will trade their souls for a varicolored bead necklace or bit of scarlet cloth.[13]

On special occasions, they fasten fragrant leaves or flowers on these rings. Even marine shells are, to some extent, employed to decorate the bejuco rings. The women wear masses of beads around their necks and long strips of cotton cloth, dyed red as usual, wound around their waists. They gather their hair in a knot at the back of the head, and tie around it bands of *nito*.

[12] Turnbull, W., op cit. 131. [13] Turnbull, W., op. cit. 132.

Tattooing is also known and practiced, though not very extensively. They call this process *cadlet.* The pigment they use is pulverized charcoal only, unlike other tribes, which employ various colors. They simply puncture the skin with some pointed metal, introduce the pulverized charcoal into the punctures, and the process is over.

This fascination for show and decoration among the Dumagats is not confined to the adults alone, but also extends to the children. In fact, the love for adornment starts in the younger ones, who enjoy decorating themselves with flowers of various colors and small fruits, which they tie around their necks, their arms, and even their legs.

The Dumagats perform a few bodily mutilations, such as the filing of all front teeth between the canines, and, to some extent, circumcision. The latter is done, with either a bolo or a knife, on boys ranging in age from 3 to 15.

LANGUAGE

The dialect spoken by this semicivilized people is a curious mixture of the different dialects spoken by their Christian neighbors. The chief tongues intermixed in their speech are the Tagalog and the Bicol languages.

> Their present dialect is closely related to the Bicol language, though there are elements in it that are doubtless survivals of their ancient speech.[14]
>
> The dialect has some kinship to that of the Ilongots, but shows evidence of wide origin. It is of interest to note the use of many words found in the Bicol dialect . . .[15]

Instances where the mixture is very noticeable occur in the following conversation between a Dumagat suitor and a maiden:

Suitor: "Ya kajatako sa alan yo kaiibig inmaadi kad sa dua yo. Iibara ko adsikamo, in wala din maadi kad sa dua yo ay kamamatay ko." (My purpose in visiting you is to reveal to you my feelings. If I shall be unable to tell you what these feelings are, I shall die.)

Maiden: "Buksan idalaid sa dua mo at ng malapdan ko." (Tell them to me, so that I may know what they are.)

Suitor: "Sumantala na pinabuksan idalad id sa adua ko ay hata at bubuksan ko. Ana kai ya at manambitan id gawang pagibig." (In as much as you consent to the revelation of my feelings towards you, I shall confess the affection that I hold for you.)

Maiden: "Kadsan ko minsan matay kagsusulan ko ay wala ta ka man laang dakpan." (For me, I do not dare to listen to what you are telling me, even if you die in my presence.)

[14] Beyer, H. O., loc. cit. [15] Turnbull, W., op. cit. 131.

The mixture may be further illustrated in the study of their vocabulary and a typical Dumagat story of the Sun and the Moon. Some Dumagat words are:

Utak. Head.
Buac. Hair.
Nguso. Mouth.
Ngipan. Teeth.
Kiret. Eyebrow.
Talinga. Ear.
Alima. Arm.
Tuus. Upper leg.
Bilies. Lower leg.
Bagtaw. Chest.
Itutuyo. Finger.
Ewang. Sky.
Dilag. Sun.
Maningas. Moon.
Umbutatala. Star.
Mabuso. Pain.
Paduro. Thunder.
Dilap. Lightning.
Layolayo. Far.
Apadnayo. Near.
Matungdo. To sleep.
Kakarawang. To jump.
Talandang. To run.
Miuutas. To fight.
Mangan. To eat.
Umindom. To drink.
Sako. I.
Kahawa. You.
Aapatamo. We.
Metbalaye. They.

DILAG AT MANINGAS

Dilag at Maningas ay ibig magsabay kasipat. Kig minautas ay wala manalo Maningas. Kakasana isa ata ay wala id makapagpakibo idsera at wala manalo isa at ugnay malakas isa. Maningas ay sumipot ata metondo. Dilag ay sumipot lalagpon ata. Metalo Maningas ida Dilag at mayaga.

THE SUN AND THE MOON

(Once the Sun and the Moon wanted to shine at the same time for they had the same brightness. They made a bet on how they could make a man move. The Moon began to shine so the man went to sleep, but when the Sun shone the man began to work. The Moon was beaten so she gave up some of her brightness to the Sun.)

POLITICAL LIFE

The Dumagats, like most semicivilized peoples, have no definite and established form of political organization. They have, however, old customs and old traditions that have come down from their forebears from time immemorial. The chief of each tribe, who must necessarily be the eldest man in the group, is the supreme head, wielding absolute authority over his subjects, running a one-man despotic government. The principal duty that he is charged with is to see that strict obedience is given to the tribal customs. Usually he finds little or no difficulty in enforcing the law, for most tribes consist of no more than four or five good-sized families.

Upon the death of a chief, there is no election, nor struggle for the vacated post, but merely the automatic ascension of the next eldest member of the tribe to the chieftainship.

FOOD

The chief food consists mostly of sea and fresh-water products, which are supplemented with forest products, and the flesh of various animals such as monkeys, wild hogs, and birds. In order to trap these animals, the Dumagats place snares on the ground and on the trees. Their method of catching fish is, on the other hand, quite peculiar and typical of them. The women—they are usually the ones assigned to this work—dive under the water with the catapult, the dart, and the water goggles in order to facilitate their sight. They try to locate the holes at the bottom of the stream. Upon finding them, they thrust the dart into the holes by means of the catapult. Mudfishes and eels comprise the usual catch.

The principal item in their food is rice, supplemented with camotes, corn, root crops, bananas, and papayas, which are grown in their kaiñgins and backyards. They make a drink which they call *painot,* made by boiling the bark of *pugahan,* a kind of palm tree, in water.

HOUSING

The Dumagats, as we have seen, never stay long in one place, but move after a time to some other locality, the chief reason for their frequent migrations being the steady invasion of the homesteaders. Hence, upon settling in a place, they construct semipermanent homes requiring little effort.

The Dumagat house (Plate 4) is very small, low, and uncomfortable. It is made of small tree trunks, bamboo, rattan, and cogon grass. The type of architecture is the truss. Six stakes intended for posts are driven into the ground in two parallel rows. The middle stake in each row is almost twice the height of the other two, which are only as high as a man's waist. In the rectangular area formed by the two high and the low stakes, a flooring of bamboo strips is made. Then the roof is constructed over the entire structure. The roof is made of cogon grass arranged so that each section, beginning from the lowest part, is overlapped by the section above it. Bamboo strips and rattan are employed to keep the grass firmly in place. When the roof is finished, the two eaves almost reach the ground.

The open sides are covered with walls of cogon grass fastened like the roof except one part, which is left open to serve the purpose of a door. There is no window of any sort nor steps for access to the elevated floor; the occupants of the house sim-

ply clamber up without the aid of stairs. There is no furniture. The only thing to be seen in the interior is sometimes a trunk and a few household articles. Visitors have to sit on the bamboo floor. The reason for this is that the house is used only for sleeping purposes, all other activities taking place outside the house; even the stove is on the ground, formed by three stones, intended to support a cooking vessel. This stove, however, is seldom used, for the common way of cooking is to suspend the container from the roof of the house on the side not occupied by the floor, and to build a fire underneath it.

The Dumagats do not repair their homes. When the materials decay they do not change them. When the house begins to lean on one side, they simply prop it up with a bamboo post. They continue to live in it as long as it is fairly habitable, then build a new one either near the old one or on the adjoining kaiñgin.

FIRE MAKING

The Dumagats are just beginning to use matches. Most of them still cling to the primitive methods of kindling fire. They seldom resort to bamboo fusing; their principal method is the *pinkian,* wherein they employ flint and steel. The fine dried husk of the pugahan, a kind of palm tree, is placed on the flint, then the steel is struck against it. The resulting sparks from the contact ignite the husk. This is then blown till the flame increases.

IMPLEMENTS

Being mainly dependent on the sea for their subsistence, the Dumagats have need of but few implements. They have a unique fishing implement, something like a catapult (Plate 3, fig. 3). They possess simply bows, bamboo arrows, and small lances, which they deftly use in pursuing and catching wild hogs. In addition, they also use bolos and hatchets for building their houses and hewing trees.

UTENSILS

The Dumagats cook their rice and meat in bamboo tubes, one end opened, the other stopped by the joint. Bowls and cups they make from polished coconut shells. To carry water they employ long bamboo tubes six to twelve joints, all joints pierced through except the bottom or the last joint. Bamboos also serve for kitchen utensils and spoons. In the absence of bamboo containers, the Dumagats use the leaves of the anahao, a

kind of palm tree, for cooking rice. The leaves are shaped into a bowl, with the ends tied. This is not common among other Filipino tribes.

INDUSTRIES

The daily work of the Dumagats is directly connected with gaining their livelihood. They have few or no industries not immediately relating to the question of food. Although the women and some of the men fish, the catch is not sold but is consumed by the catcher and her family. A little basket and mat weaving is done. There is also some trade with the lowlanders in bejuco, vines, almaciga, and various other forest products, which they gather. Little agriculture is practiced, and here the kaiñgin system is employed. The Dumagats have absolutely no knowledge of pottery.

RELIGION

The Dumagats revere several anitos, but they do not acknowledge any supreme deity.

When some good fortune happens to them, the family and the group concerned in the matter sacrifice their domesticated animals, which they obtain from the Christians in the lowlands. The leftovers are offered to the spirits of their ancestors. The officiating priest (Plate 2) is the next oldest man to the chief. The chief himself never officiates in the sacrifice for good fortune.

FAMILY LIFE

The Dumagats are monogamous; the husband sticking to the woman of his choice faithfully throughout his life, except in case of adultery, which is very rare. The discovery of adultery usually results in the separation of the husband from the wife.

MARRIAGE

Marriage takes place among the Dumagats with or without parental intervention. The young men go through a period of courtship, during which they display their bejuco rings and armlets. The priest performs the marriage ceremony.

Among the well-to-do Dumagats the marriage ceremony is performed thus: The father of the bride-to-be invites ten expert hunters and sends them into the forest to hunt deer, wild boars, and monkeys. Upon their arrival from the hunt with their catch, the animals they carry are dressed and cooked.

The bride and the bridegroom are separated at the rear of the house, and around them are assembled the guests in two groups. Around the bride are gathered her immediate relatives, while around the bridegroom are gathered his. At the signal of the priest the two groups, one headed by the groom and the other by the bride, go around the house in opposite directions, till they meet at the doorway. Here the bride and the bridegroom shake hands as the priest tells them to do so. This performance completes the ceremony, and the couple is considered married.

Among the middle-class Dumagats the marriage ceremony is simple and unimpressive. The bride and the bridegroom are given buyo by the priest. They masticate it, then with the priest standing between them, they exchange their chewed buyo. After this they go as husband and wife.

Among the poor Dumagats there is no marriage ceremony of any sort. The girl simply goes to live with her lover, and they are considered husband and wife.

After their marriage the couple decides in which house they will reside. They may choose to live with their parents; in this case, they may live with the bride's parents for a few days, then, with the bridegroom's parents, and so on alternately. If the pair is able to live independently they build their own home or have their parents build a new house for them. If the parents die the couple lives independently.

CHILDREN

Ordinarily, the mother gives birth to her child in the home of her parents. There is no special house provided expressly for the expectant mother. The husband is most often present when his wife gives birth to a child, but the midwife who assists the mother during the period of labor is an old woman skilled in the work known as *hilot* in Tagalog. The mother never takes any precaution after she has given birth to a child. She resumes her duties in the home and outside the home.

The children receive their names when they reach the age of one year or more. The name is derived from that of a person the parents like, or whose name they like. It may also be the name of some small animal; in fact, the parents choose any name that fascinates them or they believe to be an appropriate one for their child. For instance, they may name a girl *Umadikit,* signifying lady, or *Umbutatala,* signifying star. These two names are popular among girls.

During infancy every boy and girl is given a nickname. This nickname then is the one by which they are known throughout life.

AMUSEMENTS

The Dumagats enjoy dancing and usually perform around a bonfire. They also sing love *kundimans,* and accompany the songs with the *kulibao* and the *subing.* The kulibao is made of bamboo. One joint is cut into a handle for the player. The joint connecting the handle with the main part of the strip is kept as it is, but the one at the further end is pierced. At the rounded surface between the two joints a large oval hole is made. Across it the dried skin of a monkey is stretched, as a drum, and fastened firmly. A stick about a foot long is secured. A low fulcrum for it is fastened near the edge of the stretched skin. The stick is then tied with a cord across the fulcrum in a leverlike manner, with the part toward the skin longer than the other, and in such a way that the longer end of the stick presses on the skin. To play the instrument, one simply taps rhythmically the raised end of the stick; this causes the other end to beat on the skin and produce a sound like that of a small drum.

The subing, on the other hand, is simply a flute made of small, long-jointed bamboo. The diameter is about one inch or even less. The closed end of the bamboo joint is used as stopper for that end. The holes, of which there are four to six, are drilled by means of red-hot iron pressed against the surface of the flute.

The Dumagats have a great love for music. While working, playing, or walking in the forest they sing to themselves. When a Dumagat wishes to call his neighbor to partake of some food or anything, he or she usually calls by means of songs. When a man sees a young woman approaching at a distance he sings a typical Dumagat song, the words running thus:

"Dano kaya nagmula aleng lenomewen amon nig dig momay iboy dasan pinalibutin?" (From what place does this lady I am perceiving come?)

The Dumagats have one game called *male.* This is played by the unmarried adults in the following manner:

Two groups of players, one made up of males and the other of females, line up on opposite sides some distance apart facing each other. One girl tosses an article into the space between the group. Immediately, one of the young men runs to it, picks it up, and joins the female group, where he is at once sur-

rounded by young women. After him dashes the entire male group, which invades the female and attempts to pull away the one carrying the article back to the ranks. If successful, their number is again whole, but if unsuccessful, it means that the female group has one captive, while the opposite group has one member lost. This time one of the male group tosses the article, and one of the female group runs to it, picks it up and joins the male group, just as the male in the first part of the game had joined the female group. The same procedure is followed; the female group runs and tries to wrest the girl from the men. This procedure continues alternately between the two groups up to an indefinite time till one group is thoroughly annihilated through the capture of all its members.

SICKNESS AND CURE

One of the peculiarities of the Dumagats is their way of viewing sickness. Unlike other primitive peoples, they do not seem to attribute diseases to evil spirits or anitos that they have inadvertently offended. Judging from their methods of curing or counteracting sickness, it appears that they regard disease as physical in nature. This is proven by the fact that they resort to some medicines; many of them use roots of trees, leaves, and fruits for this purpose. When they contract a chill, they plunge into the water with a glowing stick and remaining sitting at the bottom for a few seconds till they are relieved of the chill. Afterwards they come out of the water and dry themselves by the fire.

Skin disease called by them *bugis,* a Dumagat term for ringworm, is very common. Other diseases are stomachache and malaria. The latter sickness is accounted for by the fact that mosquitoes abound in the uncultivated forest in which the Dumagats live. The life of these people is generally unhygienic.

DEATH AND BURIAL

When death occurs it is usually caused by stomach pain and malaria.

The burial customs are rather peculiar. If a Dumagat dies he is buried in the very place where he has breathed his last. The house is destroyed next. There is no ceremony whatsoever.

Three days after the interment, the relatives of the deceased visit the resting place carrying offerings of rice, meat, and buyo; crying and wailing aloud.

They have no belief in the return of the spirits of the dead; they say that once a person dies, he will never come back; he is gone forever. For this reason they bring food and other offerings on the third day mentioned in order to supply the dead with sufficient provisions.

CONCLUSION

The Dumagats are a people still far below the standard of civilization attained by the civilized Filipinos. However, although they still cling steadfastly to the customs and traditions that they had when the Malays came over the sea and drove them into the interiors of the islands, they are by degrees adopting the first customs of modern civilization. They do not believe in the return of the spirits of the dead. Furthermore, they regard their sickness as physical in nature and hence resort to medicine.

From their mode of living and all that has been learned about them, it is safe to conclude that these people possess considerable intelligence and possibilities for improvement. Turnbull, in his article on the Dumagats of northeast Luzon, states that they are mentally and physically superior to the Ita, whatever their ethnologic status may be. Just as the introduction of public schools among the Igorots of northern Luzon is helping these people achieve a high state of culture, so will the establishment of public schools in the Dumagat communities aid them in absorbing modern civilization and enable them to perpetuate their race.

ILLUSTRATIONS

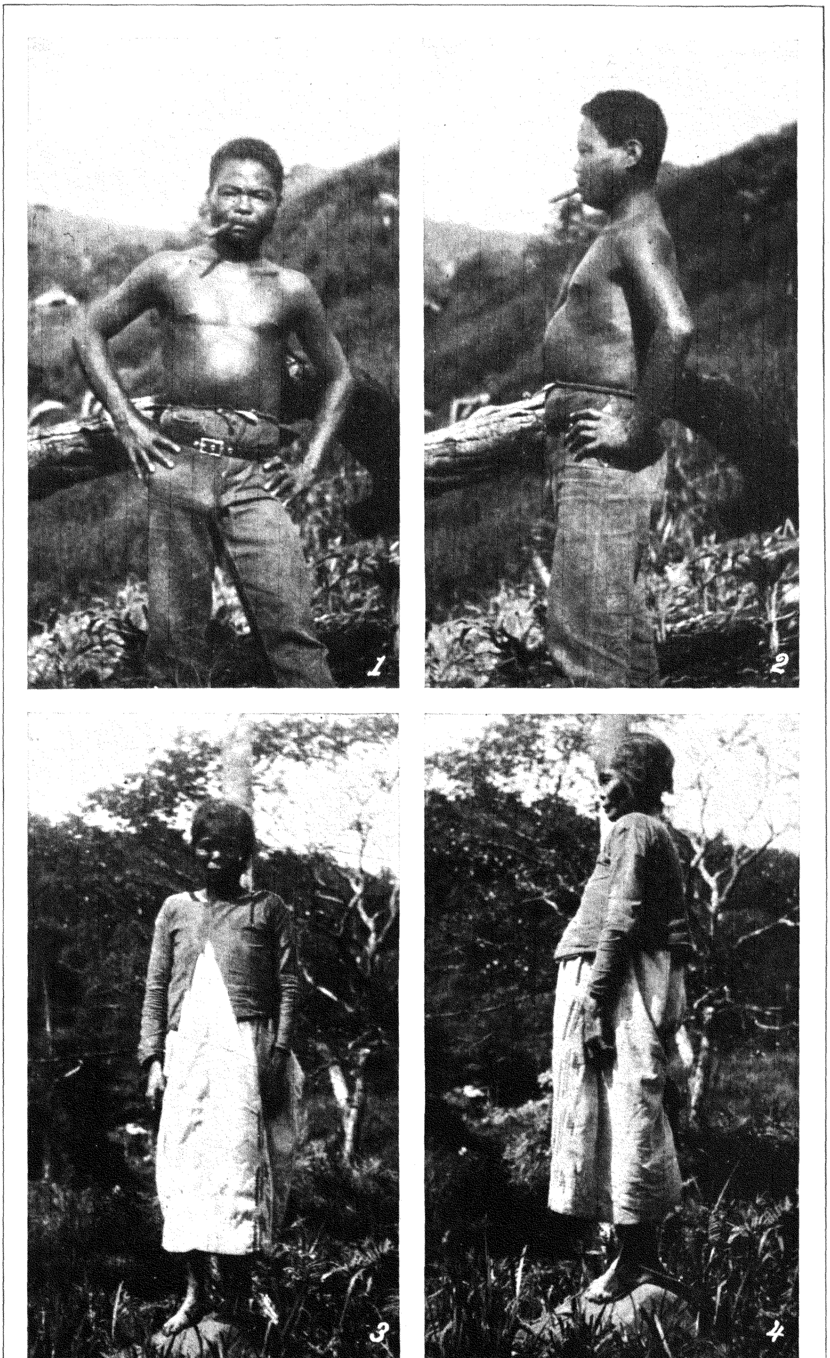

PLATE 1.

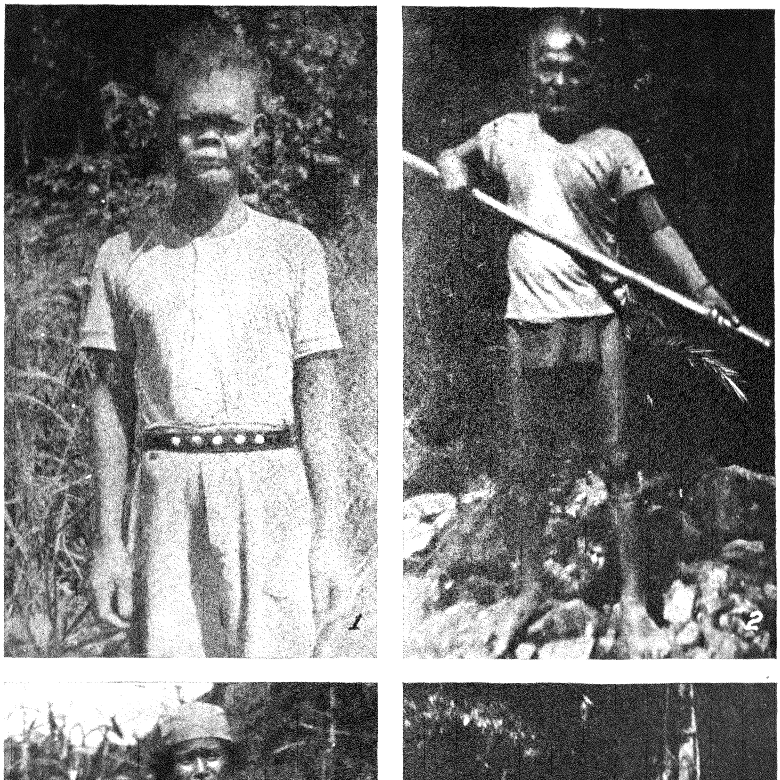

PLATE 2.

PLATE 3.

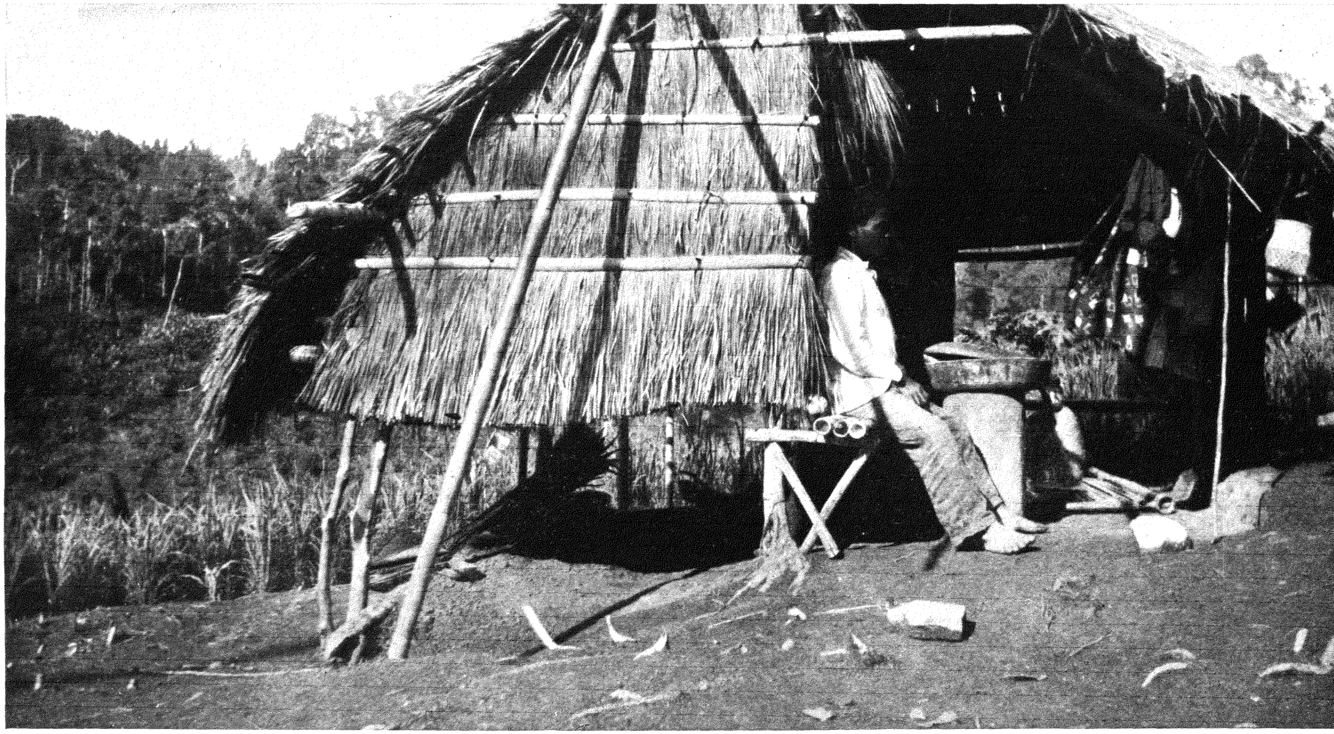

PLATE 4.

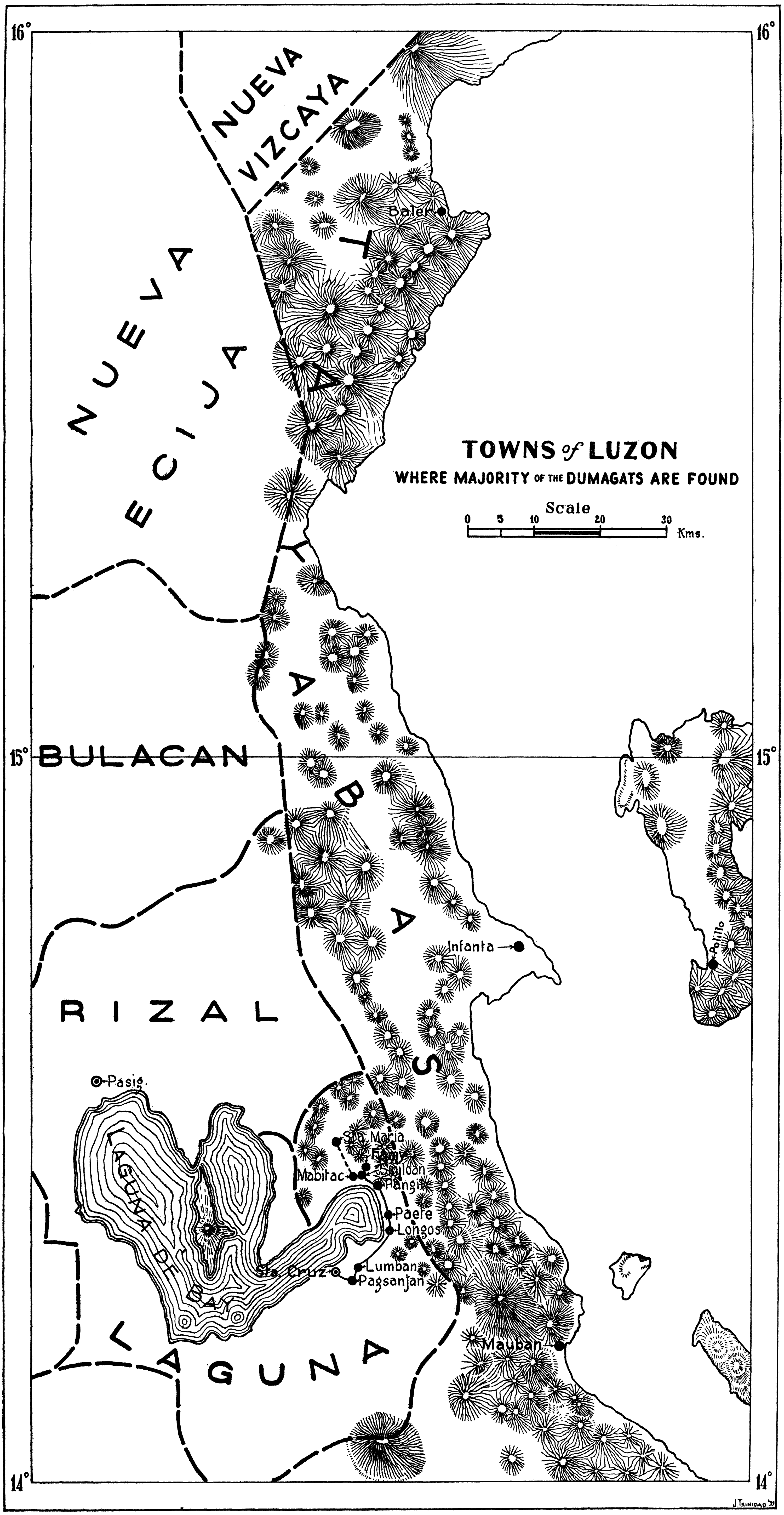

PLATE 5. PART OF LUZON.

HETEROPHYID TREMATODES OF MAN AND DOG IN THE PHILIPPINES WITH DESCRIPTIONS OF THREE NEW SPECIES.

By CANDIDO M. AFRICA and EUSEBIO Y. GARCIA

Of the School of Hygiene and Public Health, University of the Philippines Manila

FOUR PLATES

The known Philippine parasitic fauna has been very poor in heterophyid flukes. Tubangui (1933), in a paper dealing with trematode parasites of Philippine vertebrates, listed only three species of heterophyid trematodes in this country; namely, *Ascocotyle pithecophagicola* from the small intestine of *Pithecopaga jefferyi*, *Haplorchis anguilarum* from the intestine of *Anguilla mauritiana*, and *Scaphanocephalus adamsi* represented by some immature forms encysted in the fins and under the scales of *Lepidaplois mesothorax*. This report enriches our heterophyid parasitic fauna by six species parasitic in the small intestine of man and dog representing four genera and two subfamilies of the family Heterophyidæ Odhner, 1914; namely, *Heterophyes*, *Stictodora*, and *Diorchitrema*, of the subfamily Heterophyinæ, and *Monorchotrema*, of the subfamily Haplorchinæ. Three of these six species are herein described as new, two which have been obtained from both man and dog are found to be identical with *Monorchotrema taichui* Nishigori, 1924, and *Diorchitrema pseudocirrata* Witenberg, 1929, respectively, and one which was also obtained from the small intestine of man is identical with *Monorchotrema taihokui* Nishigori, 1924. The three new species are *Heterophyes expectans*, from the small intestine of Manila street dogs; *Stictodora manilensis*, from the small intestine of the same animal; and *Heterophyes brevicæca* obtained from the small intestine of an adult Filipino from La Union Province, northern Luzon, autopsied in the Manila City Morgue. The last is of especial interest because it is the first human parasitic fluke discovered in the Philippines since Garrison's discovery of *Fascioletta ilocanum* (*Echinostoma ilocanum* Garrison, 1908) about a geneneration ago.

Five more specimens of *Heterophyes brevicæca* were recovered from the small intestine at the autopsy of an adult male Filipino, native of Candon, Ilocos Sur (adjacent to La Union), associated with *Euparyphium ilocanum* and another still unidentified trematode that appears to be a new species of *Lepoderma* Looss, 1899 (*Plagiorchis* Lühe, 1899).

HETEROPHYES EXPECTANS sp. nov. Plate 1, fig. 1.

Five specimens of this fluke were obtained from the small intestine of native dogs on four occasions.

Body small, leaflike, 2.1 mm by 0.4 mm. Cuticle with scale-like spines, thickly set anteriorly, scantier after middle of body. Oral sucker subterminal, 0.190 mm by 0.115 mm; prepharynx long and capillary; pharynx 0.12 mm in breadth, œsophagus short; intestinal cæcæ simple tubes extending beyond posterior border of hind testes. Ventral sucker close to intestinal bifurcation, 0.2 mm in diameter.

Female organs.—Ovary globular, 0.18 mm by 0.11 mm, median, midway between anterior testes and acetabulum; roundish receptaculum seminis close behind, 0.14 mm by 0.11 mm. Uterine coils fill entire body from most posterior extremity to seminal vesicle. Vitellaria consist of irregularly shaped follicles, almost extracæcal, or, at least, closely applied to lateral margin, rather long, extending from level of posterior testes to first portion of seminal vesicle.

Male organs.—Testes large, roughly globular, median, removed from posterior extremity of body and placed one behind the other almost in a straight line. Posterior testes, 0.340 mm by 0.295 mm, slightly larger than anterior one, which is 0.320 mm by 0.290 mm. Seminal vesicle consists of three dilatations separated from each other by short tubules; the first part of which, or the hindermost, being the largest, and the third or expulsor portion smallest and wedge-shaped, the pointed end being directed towards the center of the gonotyl where it apparently ends in common with the similarly shaped vagina.

Genital sac alongside of and posterior to the ventral sucker, a little to the left; in stained toto mounts the two organs slightly brush each other, but in fresh specimens they are entirely separate and independent structures. It has a transverse diameter of 0.130 mm and houses a well-developed, apparently protrusible gonotyl, which bears a crown of about 105 apparently chitinous rodlets in a single row.

Eggs 0.021 by 0.013 mm, symmetrically oval with distinct "shouldering" at opercular end.

Specific diagnosis.—Heterophyes: Size 2.1 mm by 0.4 mm, body leaflike; prepharynx long and capillary, pharynx large, 0.12 mm in diameter; œsophagus short; intestine simple tubes; acetabulum removed considerably anterior from equator, alongside but independent of the genital sac; ovary in the middle of the body directly anterior to anterior testes; vitellaria long, closely applied to the lateral margin of body; testes removed from the posterior end of body, one behind the other in a straight line; uterine coils extend beyond posterior border of hind testes to extreme posterior end of body; genital sac close behind acetabulum, a little to the left, filled by a mushroomlike, apparently protrusible gonotyl, which bears a circlet of about 105 rodlets; eggs, 0.021 by 0.013 mm.

Host.—Native dog.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Witenberg (1929), following a thorough revision of members of the family Heterophyidæ, has discarded many members of doubtful validity from the genus *Heterophyes,* and recognized as valid only three species of this genus; namely, *Heterophyes heterophyes* Siebold, 1852, *Heterophyes dispar* Looss, 1902, and *Heterophyes æqualis* Looss, 1902. All the rest with the exception of *Heterophyes nocens* Onji and Nishio, 1915, which he said required further study to establish its validity, are considered synonyms of either one or another of the surviving species. However, Lane (1929) seems quite definite that *H. nocens,* which is most likely identical with *H. katsuradai* Osaki and Azada, 1926, is synonymous with the type species *Heterophyes heterophyes.*

Our specimens differ from the three established species of the genus in that (*a*) their testes are removed from the posterior extremity of the body and placed one behind the other, whereas in the established species they are obliquely in the hindermost portion of the body; (*b*) the vitellaria in our specimens are long and closely applied to the lateral margin of the body, whereas in the established species they are short with median distribution of their follicles confined between testes and ovary; (*c*) the ventral sucker in our specimens is far removed anteriorly

from the equator, whereas in the established species it is in the middle of the body; and (*d*) the rodlets in the gonotyl of our specimens are much more numerous, being around 105. Therefore, we feel that this heterophyid is a valid species, which we name *Heterophyes expectans* because its appearance in this part of the Far East has long been expected.

According to Witenberg the genus *Heterophyes* is the only one of the family Heterophyidæ that has a ventral sucker independent of the genital sac. If this claim is valid, then our specimen belongs to the genus *Heterophyes*. However, the same author by arranging all the known genera of Heterophyidæ in a table in which those belonging to one subfamily are placed in longitudinal rows and each space in the transverse direction corresponds to a definite disposition of the testes, has been able to produce a table of homologous rows, in which the parallelism in the development of the features of the different subfamilies of Heterophyidæ is, according to him, clearly seen (Table 1, Witenberg's paper, 1929). In this table Witenberg left empty squares under the different subfamilies, which are intended for still undescribed genera whose main features, according to him, can be predicted. Now it seems that *Heterophyes expectans* would prove to be a test case for Witenberg's table of homologous rows, for here we have a fluke which aside from presenting many other established characters of the genus *Heterophyes*, has a ventral sucker independent of the genital sac, but which on the other hand has its testes one behind the other and removed from the posterior extremity of the body and rather long vitellaria. Following Witenberg's formula, *Heterophyes expectans* would align itself in the same space in the transverse direction with *Microlistrum* under the tribe Cryptocotylea with regard to the disposition of the testes and character of the vitellaria, but has to be retained under *Heterophyes* with regard to the structure of the ventrogenital apparatus, or it has to align itself in the same transverse space with *Apophallus* under the tribe Heterophyea with regard to the relative position of the testes to each other. Since the present material presents more of the character of *Heterophyes* than any other genus, it seems that this confusion can be averted by retaining it under the genus *Heterophyes* as we propose herein. In the event that the validity of *Heterophyes expectans* is finally established, certain characters of this group that have been assigned generic values have to play mere specific rôles.

HETEROPHYES BREVICÆCA sp. nov. Plate 1, fig. 2.

Twenty-one specimens of this fluke were obtained at autopsy from the small intestine of a male Ilocano, 50 years old, native of La Union, Philippine Islands, who died in Manila of acute cardiac dilatation.

Body very small, 0.6 to 0.7 mm by 0.30 to 0.35 mm, pear-shaped; cuticle with scalelike spines more thickly set anteriorly than posteriorly. Oral sucker subterminal, 0.085 mm by 0.070 mm; ventral sucker slightly larger than oral sucker, 0.075 mm by 0.080 mm, postequatorial in the median line. Prepharynx three times the diameter of the œsophagus, pharynx oval, 0.035 to 0.040 mm by 0.035 mm, œsophagus long, intestines short but large, being from three to four times larger than œsophagus, their blind ends never extending posteriorly beyond the acetabulum.

Female organs.—Ovary globular, 0.075 to 0.080 mm by 0.060 to 0.065 mm, at about the same level as the acetabulum to the right side; receptaculum seminis close behind, concealed by the coarse vitelline follicles; uterine coils limited to the posterior half of the body, their terminal portion meandering along the left side anteriorly to end at the vagina, which runs towards the genital sac. Vitellaria consist of five or six large follicles (0.06 by 0.04 mm) on either side, which obscure the testes; the transverse vitelline duct very prominent, running like a bridge across the median field behind the acetabulum.

Male organs.—Testes globular or ovoid, 0.105 mm by 0.070 mm, removed considerably from the posterior extremity on the same level with the vitellaria, and on the same plane with reference to each other. Seminal vesicle very large, looped over on the anterior side of the ventral sucker, its first portion being the largest and most prominent, occupying almost the entire triangular space formed by the acetabulum and the intestines.

The excretory vesicle forks almost immediately into two large vesicular arms each of which after running along the posterior side of the body turns medially to send off a small tubule which runs vertically upward to the vicinity of the pharynx.

Eggs, 0.016 by 0.010 mm.

Specific diagnosis.—*Heterophyes:* Size 0.06 to 0.07 mm by 0.3 mm; body pear-shaped; cuticle with scalelike spines; prepharynx large, three times as large as œsophagus; pharynx ovoid; œsophagus long; intestines simple, very short, never extending beyond level of ventral sucker; acetabulum slightly

TABLE 1.—*Character differentiation among H. heterophyes (von Siebold, 1852), H. dispar (Looss, 1902), H. æqualis (Looss, 1902), H. expectans sp. nov., and H. brevicæca sp. nov.*

Character.	*H. heterophyes.*	*H. dispar.*	*H. æqualis.*	*H. expectans.*	*H. brevicæca.*
Size........ mm...	2.7×0.9	0.4–1.4×0.2–0.4	0.4–0.9×0.2–0.4	2.1×0.4	0.6–0.7×0.3–0.35
Pharynx.... mm...	0.03–0.06	0.03–0.04	0.02–0.4	0.1	0.035–0.040×0.035
Œsophagus........	Long.................	Long.................	Long.................	Very short.................	Long.
Intestines..........	Simple, reaching the posterior extremity of the body where they turn round the testes.	Similar to those of *H. heterophyes.*	Four or five times the diameter of the œsophagus, never extend beyond testes.	Similar to those of *H. heterophyes.*	Short, never extending beyond level of acetabulum.
Ventral sucker......	About middle of the body.	About middle of the body.	About middle of the body.	Removed a considerable distance anteriorly from middle of body.	Postequatorial.
Genital sac.........	Almost as large as ventral sucker; gonotyl armed with 73–87 rodlets.	Does not exceed half of the diameter of ventral sucker; gonotyl bears 25–30 thin spines.	Somewhat smaller than ventral sucker; gonotyl with a circlet of 15–25 thin spines.	About half as large as ventral sucker; gonotyl with circlets of about 105 spines.	Genital sac about half as large as ventral sucker; gonotyl with circlet of spines, number undetermined.
Disposition of testes.	Obliquely in the hindermost portion of body.	As in *H. heterophyes*	As in *H. heterophyes*	One behind the other, removed a considerable distance from the posterior extremity of body.	Obliquely, removed considerably anteriorly from the posterior extremity of body.
Vitellaria..........	Short, confined between the levels of testes and ovary; mostly intracæcal.	Similar to that of *H. heterophyes.*	Similar to that of *H. heterophyes.*	Long, extending a considerable distance beyond the anterior border of ovary; mostly extracæcal, or at least closely applied to the margin of body.	Short, follicles few and very coarse, 5 or 6 on each side, confined in the region of testes, postcæcal, each follicle about 0.06 mm × 0.04 mm.

Uterus	Fills the whole free space between testes and ventral sucker; does not extend beyond these levels.	As in *H. heterophyes*	As in *H. heterophyes*	Extends behind testes to the extreme posterior end of body.	Confined between level of the acetabulum and posterior end of body.
Seminal vesicle	Posterior to acetabulum.	Posterior to acetabulum	Posterior to acetabulum	Posterior to acetabulum	Anterior to acetabulum.
Ovary	Median and posterior to acetabulum.	As in *H. heterophyes*	As in *H. heterophyes*	As in *H. heterophyes*	On the right side of and on the same level with acetabulum.
Eggs ... mm	0.023–0.027×0.013–0.015	0.021–0.023×0.013–0.015	0.023–0,025×0.014–0.016	0.02–0.022×0.013–0.015	0.016×0.01

larger than oral sucker, 0.09 by 0.08 mm, postequatorial and median; ovary roundish, 0.075 to 0.080 by 0.06 to 0.065 mm, anterolateral to acetabulum; uterine coils fill posterior half of body; vitellaria consist of coarse follicles, 0.060 by 0.040 mm; testes ovoid, 0.105 by 0.070 mm, removed considerably from posterior extremity, on same level; seminal vesicle anterior to acetabulum, consisting of three saculations separated from each other by short tubes; genital sac separate and independent from acetabulum, to the right of the latter and housing mushroomlike gonotyl crowned with a circlet of rodlets; excretory vesicle horseshoe-shaped; eggs, 0.016 by 0.010 mm.

Host.—Man, native of La Union Province, Philippine Islands.

Location.—Small intestine.

Locality.—Manila, Philippine Islands (?).

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Compared with the established members of the genus *Heterophyes*, this fluke differs from any one of them as will be noted in our comparative table in the length of the intestines, in the position of the ovary and seminal vesicle, in the size of the vitelline follicles, in the form of the excretory vesicle, and the distance of the testes from the posterior end of the body. We name this new human heterophyid *Heterophyes brevicæca* on account of its short intestines.

STICTODORA MANILENSIS sp. nov. Plate 2, figs. 1 to 3.

Nineteen specimens of this fluke were obtained from the small intestines of two Manila street dogs.

Body small, 1.31 mm by 0.32 mm, oblong, all the reproductive organs contained in the enlarged posterior portion; cuticle spinous; oral sucker subterminal, 0.05 to 0.06 mm, prepharynx long, pharynx ovoid, 0.03 to 0.04 mm, œsophagus short, intestine simple tubes extending to the posterior end of the body. Ventral sucker present but rudimentary, incorporated with the genital sac at its anterior wall.

Female organs.—Ovary round, 0.095 by 0.080 mm, in front of the right testes; receptaculum seminis between the testes; uterine coils fill the posterior half of the body; vitellaria consist of rather small follicles arranged in transverse rows in the hind fourth of the body.

Male organs.—Testes transversely oval, obliquely one behind the other in third fourth of the body, posterior testes being slightly larger, 0.090 by 0.072 mm, than anterior, 0.062 by 0.061 mm;

vas deferens consists of three sacculations, separated by short tubes, located between the genital sac and the ovary.

Genital sac ringlike, 0.045 by 0.040 mm, preëquatorial, occupied completely by a pear-shaped protrusible gonotyl that bears at its tip a circlet of 12 to 15 chitinous plates resembling the hooklets of *Tænia;* that is, they are provided with handle, guard, and blade. Excretory vesicle Y-shaped.

Eggs, 0.025 to 0.026 by 0.014 to 0.015 mm.

Specific diagnosis.—Stictodora: Body small, 1.31 mm by 0.32 mm, oblong; both prepharynx and œsophagus prominent; ventral sucker present but rudimentary on the anterior wall of the genital sac; testes obliquely one behind the other in the posterior part of the middle third of the body; ovary anterior to the right testis; seminal receptacle between testes; uterine coils between the genital sac and posterior end of the body; genital sac filled by protrusible pear-shaped gonotyl which bears a crown consisting of a single row of 12 to 15 chitinous plates that resemble the hooklets of *Tænia;* excretory duct Y-shaped.

Host.—Native dog.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimen.—Parasitological collection, Department of Parasitology, School of Hygiene and Public Health, University of the Philippines.

Remarks.—In comparing this fluke with *Stictodora sawakinensis* Looss, 1899, the only member of the genus, we find that our specimen differs from it in the structure of the gonotyl. In Witenberg's account the cone of the gonotyl of *S. sawakinensis* is covered with six to ten longitudinal rows of triangular plates, whereas in our specimen this portion of the gonotyl bears only a circlet of chitinous plates which individually resemble the hooklets of *Tænia.* Moreover, according to Witenberg, there is no ventral sucker either in the genital sac or outside of it in *S. sawakinensis,* whereas longitudinal sections of our specimen show the presence of this organ on the anterior wall of the genital sinus. Therefore, we feel justified in describing our specimen as a new species, which we name *Stictodora manilensis* after the locality where it was first found.

MONORCHOTREMA sp. Plate 3, figs. 1 and 2.

Eight specimens which showed characters of this genus were obtained from the small intestines of five dogs and four from the

small intestine of an adult male Filipino, native of Leyte and residing in Manila at the time of his death. A comparative study of both our human and dog specimens, which we believe represent a single species, with *Monorchotrema taichui* Nishigori, 1924, as described by Witenberg (1929), convinced us that our material represents that species. A short time later we encountered at autopsy in the small intestine of a 60-year-old man, native of Calivo, Capiz, and residing in Manila at the time of his death due to cardiac dilatation, five specimens of what appeared to be a different species of this genus, which we cannot distinguish from *Monorchotrema taihokui* Nishigori, 1924, and which most likely represents that species. Although Faust and Nishigori (1926) succeeded in rearing both trematodes experimentally in man, ours seem to be the first natural human infestations of these heterophyids. The primary intermediate hosts of *M. taichui* and *M. taihokui* in Formosa are *Melania oblique-granosa* (Smith) and *M. reiniana* var. *hidachiens*, respectively; the secondary represented by various species of fish belonging to the families Cyprinidæ, Siluridæ, and Cotilidæ according to the results of feeding experiments conducted by Faust and Nishigori (1926) on man, dog, and cat.

DIORCHITREMA sp. Plate 3, fig. 3.

Forty specimens of this fluke were recovered from the small intestine of three dogs and four from the small intestine of the human host mentioned above in connection with *Monorchotrema taichui.* On comparing our dog and human specimens (which we believe represent a single species) with *Diorchitrema pseudocirrata* Witenberg (1929) we failed to find differences that can be considered specific, or such that might not be produced by variations in methods of fixation or degree of tissue contraction of the flukes. We, therefore, believe that our specimens are identical with *Diorchitrema pseudocirrata* Witenberg, 1929. So far as we are aware this is the first record of human infestation with this trematode. In Palestine the secondary intermediate hosts of *Diorchitrema* are fishes of the genus *Mugil,* which is represented in this country by *talilong, banak,* or *balanak,* so presumably human and dog infestation with this fluke here is contracted by eating raw fish belonging to these species and allied forms.

GENERAL REMARKS

The finding of various heterophyid flukes in man and dog in the Philippines marks a new area in the geographic distribution of this group of parasites, although such has been expected on account of our close proximity to China and Japan where both human and animal infestations with members of this group have been frequently observed and reported, and because of the presence here of melanoid snails and various species of fish of the genus *Mugil,* which act as primary and secondary intermediate hosts, respectively, of these parasites wherever they have been found to occur. That these flukes are quite common in Philippine dogs is shown by the fact that of sixty-six autopsies four dogs were found to be infested with *Heterophyes expectans* sp. nov.; five with *Monorchotrema* sp.; three with *Diorchitrema* sp.; and two with *Stictodora manilensis* sp. nov. It seems strange that Wharton (1917) failed to find any member of this group in his autopsies of one hundred eighteen dogs in Manila.

Dr. Marcos Tubangui, of the Bureau of Science, Manila, has had a similar experience. We venture to predict that careful autopsies of our cat population will yield a similar heterophyid parasitic fauna.

It was the finding of these flukes in our dogs that stimulated us to look for similar parasites among the native human population. Our curiosity was amply rewarded by finding not only both *Monorchotrema* and *Diorchitrema* sp., which we encountered previously in dogs, but also a new species, *Heterophyes brevicæca,* even before our tenth autopsy in the Manila City Morgue. The first two flukes were from the small intestine of an adult Filipino, native of Leyte Island, but residing in Manila at the time of his death due to acute cardiac dilatation; the last from the small intestine of an adult male Filipino, native of La Union, northern Luzon, but residing in Manila at the time of his death due to the same cause. Later another *Monorchotrema,* which answers the description of *Monorchotrema taihokui* Nishigori, 1924, was encountered in the small intestine at the autopsy of an old man from the Visayas. It is significant that in the regions from which they came the people are known to have the habit of eating raw fish as do the Chinese and Japanese, a practice that is not looked upon with favor in the Tagalog provinces as far as we know. What we cannot explain

is how these infestations (which judging from the ease with which we encountered them at autopsy seem quite common, at least among our raw-fish-eating population) escaped detection during the last thirty years of active routine fæcal examination in private and Government laboratories, considering the fact that their eggs are larger and even more conspicuous than the cysts of *Entamœba histolytica* and other intestinal Protozoa.

To determine the species of fish that serve as the secondary intermediate hosts of these flukes, feeding experiments, involving puppies and kittens divided into lots each of which is fed from time to time with a species of fish commonly sold in Manila markets, are now in progress.

SUMMARY

Six species of heterophyid trematodes hitherto unknown in the Philippines are reported in this paper. Of these six species, three have never been described before; namely, *Heterophyes expectans* sp. nov. and *Stictodora manilensis* sp. nov. from the small intestines of dogs, and *Heterophyes brevicæca* sp. nov., from the small intestine of a native Filipino. Of the remaining three species, two that were recovered from the small intestine of man and dog cannot be distinguished from *Monorchotrema taichui* Nishigori, 1924, and *Diorchitrema pseudocirrata* Witenberg, 1929, respectively; while the last, which is identical with *Monorchotrema taihokui* Nishigori, 1924, was obtained from man. This is the first time that these last three flukes are reported in man as natural infestations. A critical note on Witenberg's (1929) table of homologous rows, which is intended to show the parallelism in the development of the features in the different subfamilies of Heterophyidæ, is included.

ACKNOWLEDGMENT

We gratefully acknowledge our indebtedness to the Departments of Pharmacology and Physiology and Biochemistry for their courtesy in turning over to us for this investigation the bodies of their used dogs, to the Department of Pathology and Bacteriology for permitting us to obtain material from their autopsies, and to Dr. Walfrido de Leon, head of the Department of Sanitary Bacteriology and Immunology, for the microphotography.

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ILLUSTRATIONS

[Drawings by Mr. V. V. Marasigan.]

ABBREVIATIONS

os, Oral suckers.
ac, Acetabulum.
gs, Genital sac.
gtl, Gonotyl.
vs, Vesicula seminalis.
rs, Receptaculum seminis.
oes, Œsophagus.
ov, Ovary.
t, Testes.
cp, Cirrus pouch
ut, Uterus.
vag, Vagina.
vg, Vitelline glands.
exb, Excretory bladder.
ed, Ejaculatory duct.
pg, Prostatic glands.
exp, Expulsor.

PLATE 1

FIG. 1. *Heterophyes expectans* sp. nov., entire worm, ventral view.
2. *Heterophyes brevicæca* sp. nov., entire worm, ventral view.

PLATE 2

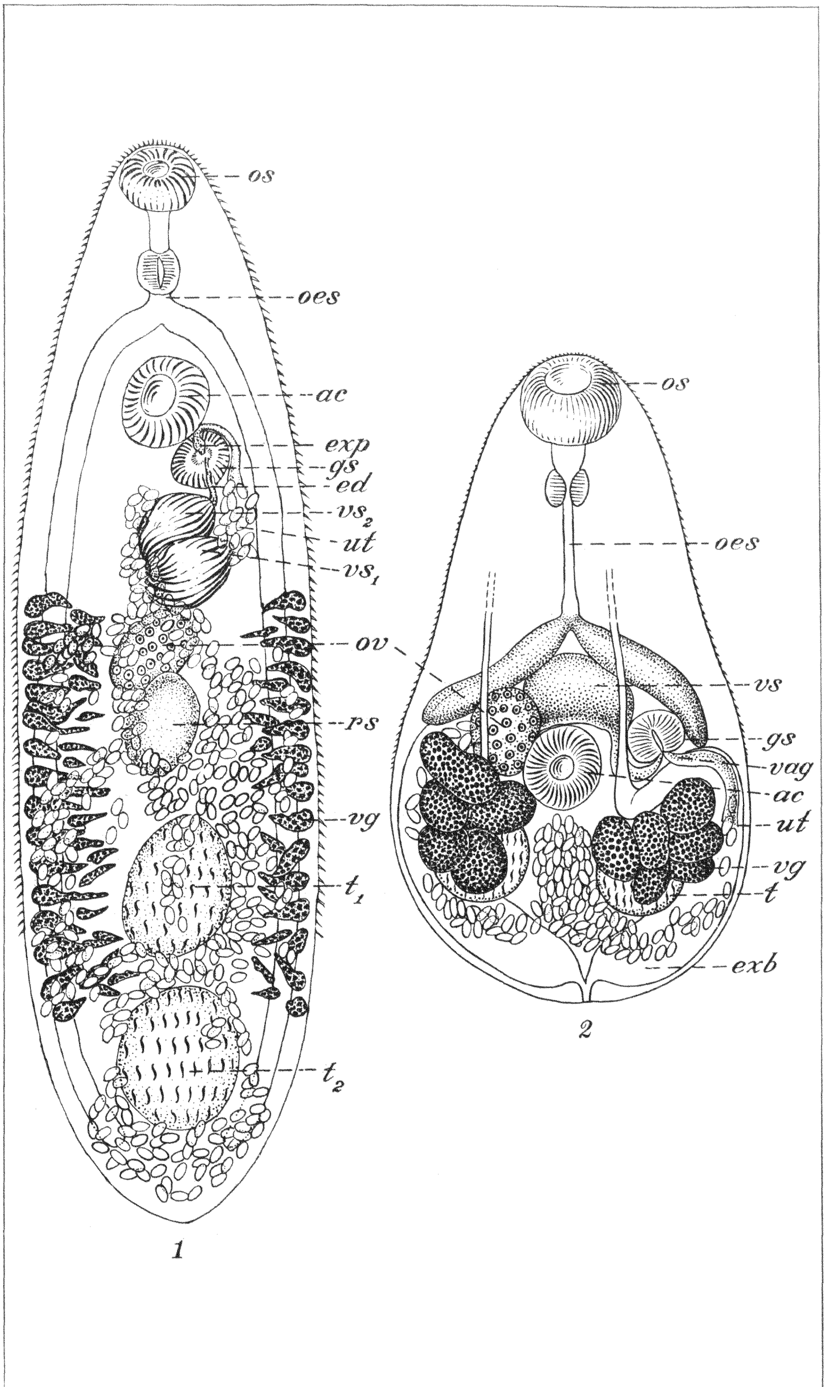
FIG. 1. *Stictodora manilensis* sp. nov., entire worm, ventral view.
2. *Stictodora manilensis* sp. nov., showing transverse section, the tip of the gonotyl with the single circlet of spines.
3. *Stictodora manilensis* sp. nov., transverse section, showing the rudimentary ventral sucker. Figs. 2 and 3 are from the same specimen.

PLATE 3

FIG. 1. *Monorchotrema* sp., entire worm, ventral view, indistinguishable from *M. taichui* Nishigori, 1924.
2. *Monorchotrema* sp., entire worm, ventral view, indistinguishable from *M. taihokui* Nishigori, 1924.
3. *Diorchitrema* sp., entire worm, ventral view, indistinguishable from *D. pseudocirrata* Witenberg, 1929.

PLATE 4

FIG. 1. *Heterophyes brevicæca* sp. nov., entire worm.
2. *Heterophyes expectans* sp. nov., anterior end not showing.
3. *Heterophyes expectans* sp. nov., the acetabulo-genital area showing the rodlets of the gonotyl.
4. *Stictodora manilensis* sp. nov., anterior end not showing.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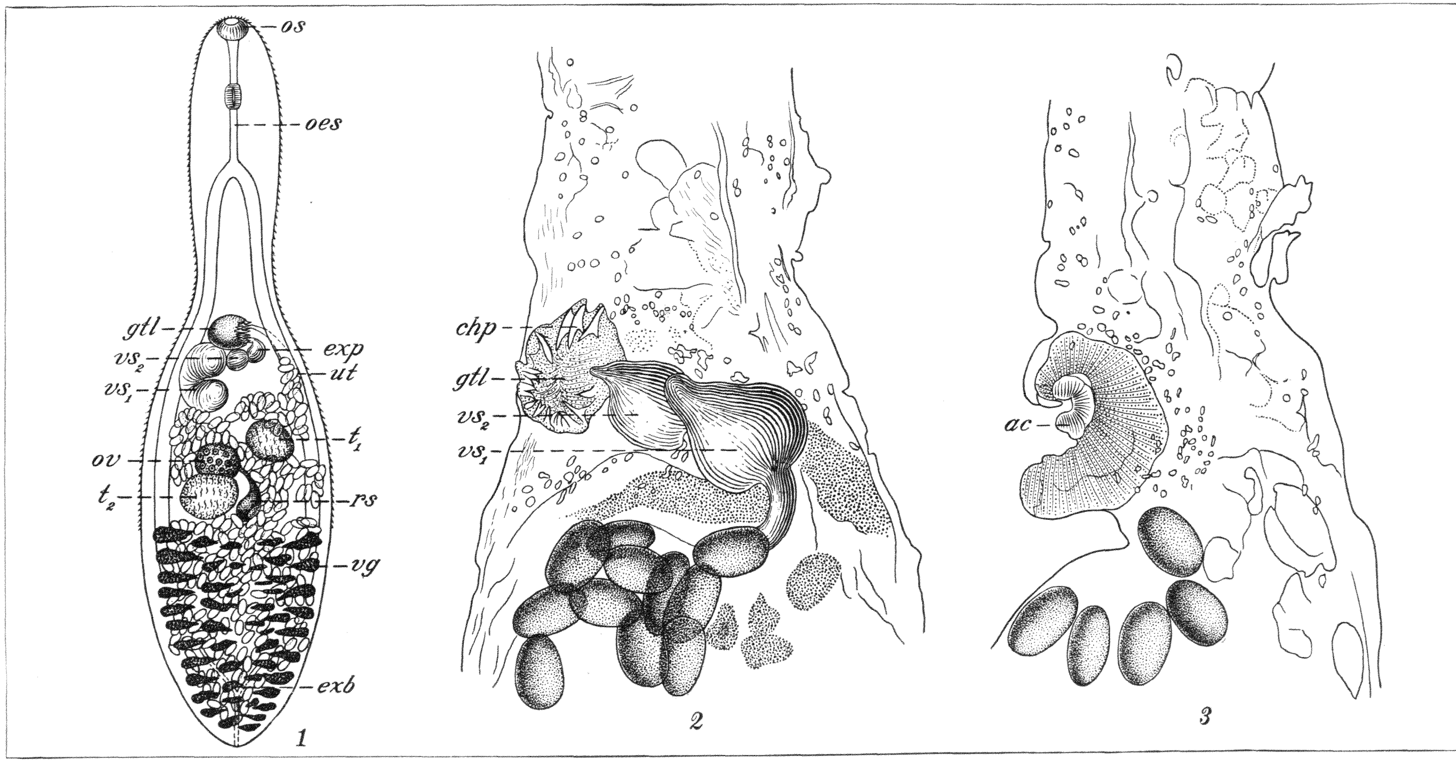

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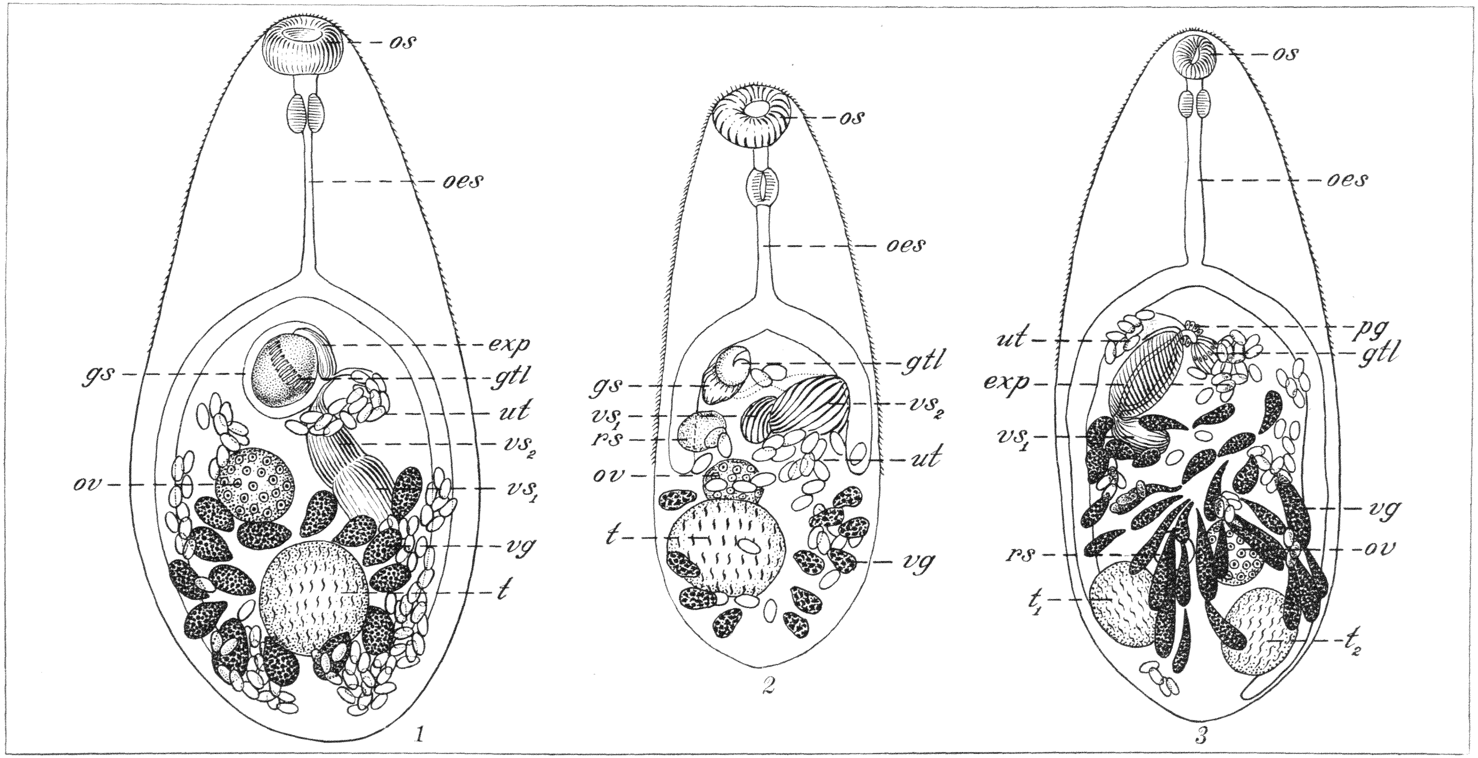
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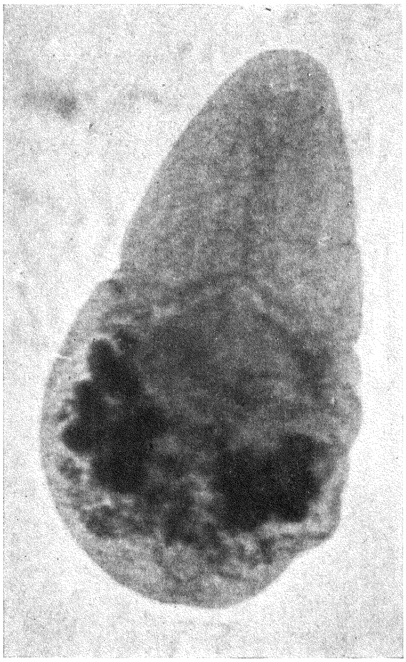
PLATE 3.



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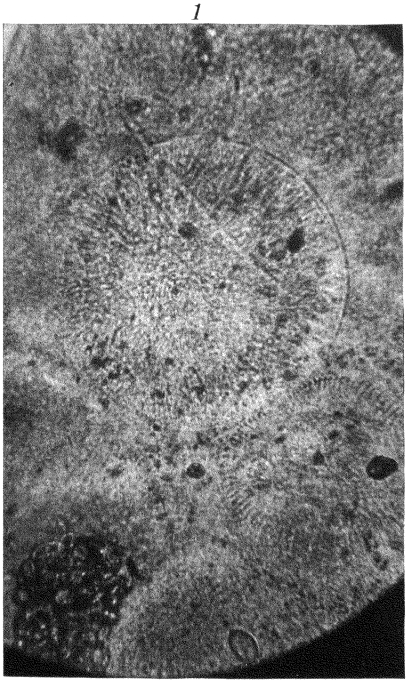

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PLATE 4.

RESULTS OF THE BACTERIOLOGICAL EXAMINATION OF ICE DROPS MANUFACTURED IN MANILA

By TERESA V. ROSARIO-RAMIREZ and ONOFRE GARCIA

Of the Division of Biological Products, Bureau of Science, Manila

THREE PLATES

Of the various kinds of frozen preparations used as refreshment food in the Philippines, there is a product, the "ice drop," which, because of its low price when compared with that of ice cream, is in great demand by the public in general. The manufacture of ice drops requires no special or technical knowledge. In fact it is so simple that in no time several factories have been established in Manila and in many provinces.

Since ice drops are classified as foods, their preparation must conform to certain sanitary regulations prescribed by the Bureau of Health. For this reason the factories are subjected to rigid inspections and the products are frequently submitted to the Bureau of Science for bacteriologic examination. The results of the examinations are recorded in this paper, and recommendations are made on how the products may be improved from the bacteriologic standpoint.

PREPARATION OF ICE DROPS

Materials used.—Ice drops are frozen mixtures containing sugar, cereals or root products, fresh or preserved fruits, water, and sometimes milk. Artificially colored and flavored stuffs are often used in place of fruits.

The flavoring substances most often used are extracts of lemon, strawberry, orange, vanilla, pineapple, and banana. The local fresh fruits and cereals commonly employed are listed in Table 1.

TABLE 1.—*Local and botanical names of the common local fresh fruits, root products, and cereals used for making ice drops.*

Ube. *Dioscorea alata* Linn.
Macapuno. *Cocos nucifera* Linn.
Buco. *Cocos nucifera* Linn.
Nangka. *Artocarpus integra* (Thunb.) Merr.
Piña. *Ananas comosus* (Linn.) Merr.
Melon. *Cucumis melo* Linn.
Avocado. *Persea americana* Mill.
Papaya. *Carica papaya* Linn.
Mango. *Mangifera indica* Linn.
Atis. *Anona squamosa* Linn.
Pinipig (toasted rice). *Oriza sativa* Linn.
Lechias. *Litchi chinensis* Sonn.
Corn. *Zea mays* Linn.
Banana. *Musa sapientum* Linn.

In order to give ice drops a certain consistency, a thin solution of "gaogao" (starch prepared from the roots of *Manihot utilissima* Pohl) is frequently added to the mixture. An ice drop is named after the principal substance used in its preparation, and its price depends upon the quality of its ingredients.

Freezing apparatus.—The freezing apparatus is an ice box, at the bottom of which are coiled brass pipes submerged in a saturated solution of calcium chloride (Plate 1). The cooling is done by running into the brass pipes ethyl chloride supplied from a tank by a motor. In order to produce a uniform cooling, the saturated solution of calcium chloride is slowly stirred by a paddle moved by an electric motor. A large factory has at least three or four of these freezers and one refrigerating ice-drop cabinet (Plate 2).

Method of freezing.—The mixture to be frozen is placed in molds and then a wooden or bamboo stick previously washed in boiling water is introduced into each mold (Plate 3, fig. 1). The stick serves as a holder for the frozen product. As shown in Plate 1, the filled molds are placed on a tray provided with circular holes. Each tray can hold as many as sixty-four molds and one ice box can accommodate two trays at a time. The trays are so placed inside the ice box that the molds are submerged to about four-fifths of their length in the solution of calcium chloride. The average time required to freeze a mixture is from fifteen to twenty minutes. When frozen the molds are taken out one by one from the ice box and each is dipped quickly in

warm water in order to facilitate the removal of the frozen product. The ice drop (Plate 3, fig. 2) is then removed from its mold by means of the stick holder, wrapped in glazed paper, and stored in the cool ice-drop cabinet.

MATERIALS AND METHODS

The samples of ice drops examined were collected by sanitary inspectors of the Bureau of Health in sterilized bottles and were received in the laboratory in the melted state. Between January, 1933, and January, 1934, 1,210 samples were examined, of which 897 were obtained directly from factories and 313 were collected from peddlers.

The samples were diluted with sterile distilled water in the proportion of 1 part of ice drop to 10 or 100 parts of the mixture, depending upon the consistency of the sample. For the bacterial count 0.1 cubic centimeter of the mixture was plated in ordinary meat-extract agar and incubated at 37° C. for forty-eight hours. For the isolation of *Bacillus coli* Durham's and Smith's fermentation tubes containing lactose broth were inoculated with 1 and 10 cubic centimeters, respectively, of the mixture.

RESULTS OF EXAMINATIONS

The results of the bacterial counts are summarized in Table 2. In this table the standard of not more than 100,000 bacteria

TABLE 2.—*Results of bacterial examination of 1,210 ice drops.*

Colonies per cc.	Samples collected from factories.		Samples collected from peddlers.		Total samples.	
		Per cent.		*Per cent.*		*Per cent*
0–100,000	269	29.99	156	49.84	425	35.12
100,001 +	628	70.01	157	50.16	785	64.88
Total	897	100.00	313	100.00	1,210	100.00

per cubic centimeter of sample prescribed by the Bureau of Health (Food and Drugs Act) is used to classify the results of our examinations. Of the 897 samples collected directly from factories, 269, or 29.99 per cent, had counts of from 0 to 100,000 colonies per cubic centimeter, and 628, or 70.01 per cent, had more than 100,000 colonies per cubic centimeter each. Of the 313 samples collected from peddlers, 156, or 49.84 per cent, had

counts not exceeding 100,000 colonies per cubic centimeter, while 157, or 50.16 per cent, had more than 100,000 colonies per cubic centimeter. Considering the total number of samples examined, 425, or 35.12 per cent, met the standard requirement of the Bureau of Health, while 785 samples, or 64.88 per cent, had an excessive number of bacteria.[1]

The number of samples that were positive to the presumptive test was 867, or 71.6 per cent. From none of these samples, however, was *Bacillus coli* isolated, the inoculated eosin-methylene-blue-agar plates showing mostly organisms of the *aerogenes* group. It has been shown by Schöbl and Ramirez (1925) and Schöbl and Rosario-Ramirez (1931) that this group of bacteria is very widely distributed in nature. Quoting from Schöbl and Ramirez, "The presumptive test is used as a preliminary test and as an indication of whether or not a further search for *B. coli* should be attempted. A positive presumptive test indicates that some sugar fermenters (lactose) are present. *Bacillus coli* is only one of the many bacteria that ferment sugars. Consequently, not much significance should be attributed to this test, particularly when the colony count is low and the bacteria responsible for the fermentation are of the *aerogenes* group. It has been demonstrated that this group of bacteria in the Tropics is ubiquitous. They are present in places far remote from any possible fæcal pollution and this group of bacteria includes forms that are present in soil and vegetation and which cannot be distinguished either by cultural or serologic methods from the same species encountered in the fæces."

In order to find the probable reasons for the large percentage of samples that failed to meet the bacteriological standard prescribed by the Bureau of Health, an inquiry was made into the bacterial counts of the different ingredients used in the preparation of ice drops. It was found, as shown in Table 3, that the

[1] As noted elsewhere, the ice drops were received in the laboratory in the melted state and the examinations were usually made after two hours from the time the samples were collected by sanitary inspectors. In order to determine if any appreciable increase in the original colony count of a sample takes place during this time interval, arrangements were made with Dr. Paulino K. Navarro, of the Bureau of Health, to send us products packed in dry ice. These were received intact in the laboratory and were examined at different intervals of time. The results showed that up to two hours after the collection of the samples, the differences in the colony counts were negligible.

TABLE 3.—*The bacterial content of some of the extracts and colored foodstuffs used in the preparation of ice drops.*

Materials examined and manufacturers.	Colonies per mg.		Presumptive test.
	Immediate plating.	After standing for 48 hrs.	
I. G. Farbenindustrie Aktiengesellschaft, Frankfurt am Main, Germany.			
(*a*) Egg yellow (powder)	60	30	Negative.
(*b*) Violet 237 (powder)	30	60	Do.
(*c*) Red (powder)	75	45	Do.
(*d*) Lemon yellow (powder)	60	30	Do.
II. Joseph Chemical Laboratory, 674 Evangelista, Quiapo, Manila.			
(*a*) Egg yellow (powder)	1,320	291,900	Do.
(*b*) Red (powder)	165	150	Do.
	Colonies per cc of a dilution of 1 to 10 cc.		
(*c*) Banana extract (liquid)	46	30	Do.
(*d*) Orange extract (liquid)	30	90	Do.
Boiled water from one ice-drop factory (undiluted)	50	26,330	Do.
III. Watsonal Drug Co., Maniia.			
(*a*) Raspberry extract (liquid)	0	240	Do.

high bacterial content of the samples could not be attributed to the use of fruit extracts and artificially colored stuffs. The suspicion falls on the use of fresh fruits, cereals, and coconut milk, for in going over the list of ice drops of known composition it was noted that the large majority of the samples which had these materials as the principal ingredients had very high bacterial counts.

RECOMMENDATIONS

Manufacturers of ice drops could improve the quality of their products from the bacteriological standpoint by observing simple precautions in addition to the rules and regulations given in the Bureau of Health Administrative Orders No. 70 and 93 and in Administrative Decision No. 228, adopted August 15, 1934, by the Board of Food Inspections. These precautions are the following: (*a*) Only water that has been recently boiled should be used for diluting the ingredients; (*b*) the hands of those engaged in the preparation of ice drops should be thoroughly cleansed; and (*c*) in order to maintain as much as possible the original bacterial content of a mixture, the latter should be frozen within three hours after its preparation.

SUMMARY AND CONCLUSIONS

During the period from January, 1933, to January, 1934, 1,210 samples of ice drops were received at the Bureau of Science for bacteriological examination. Of these, 785, or 64.8 per cent, had bacterial counts exceeding the standard of 100,000 colonies per cubic centimeter recommended in the Food and Drugs Act. In the routine manufacture of ice drops, as it is now being done in most of the factories, it cannot be expected that the bacterial counts of these products will always conform to the prescribed standard, but our observations indicate that such a standard is within reasonable limits and that it should therefore be maintained.

Of the total number of samples examined, 867, or 71.6 per cent, gave positive presumptive tests, but none was positive for *Bacillus coli.* The wide distribution in nature of sugar-fermenting bacteria other than *Bacillus coli* is probably responsible for the large number of samples giving positive presumptive tests. On the other hand, the large percentage of samples with high bacterial counts is due either to faulty handling of the products or to the use of badly contaminated ingredients. Recommendations are given in order to help the manufacturers of ice drops to keep the bacterial counts of their products at a minimum.

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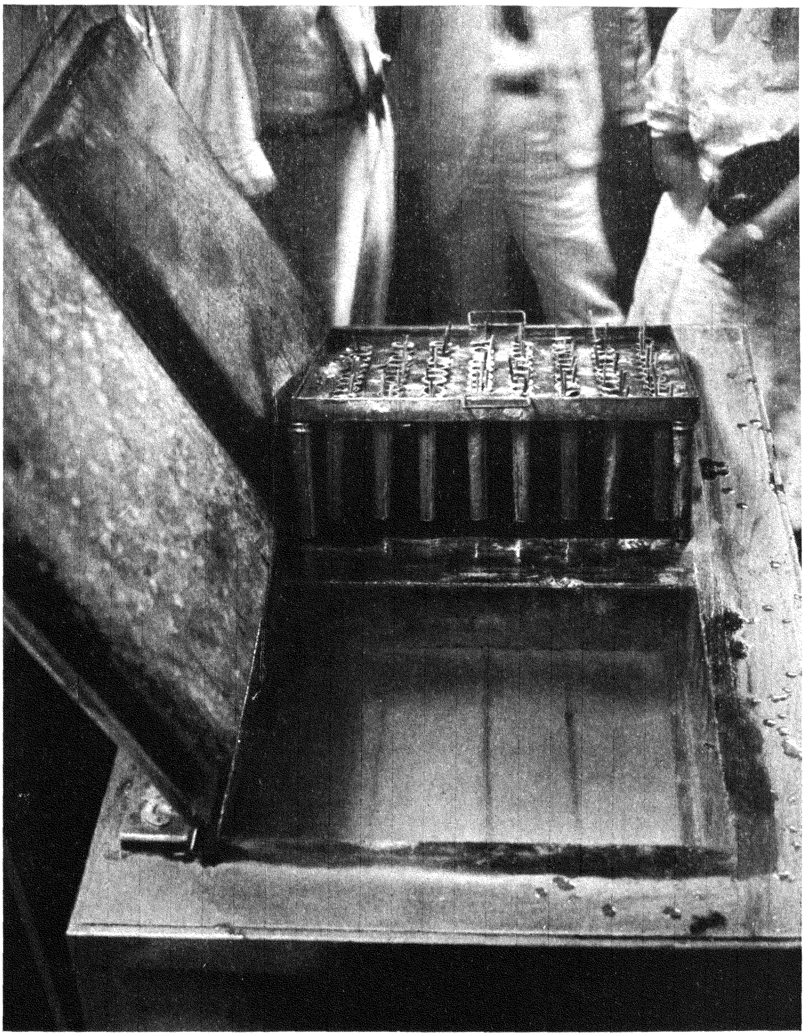
ILLUSTRATIONS



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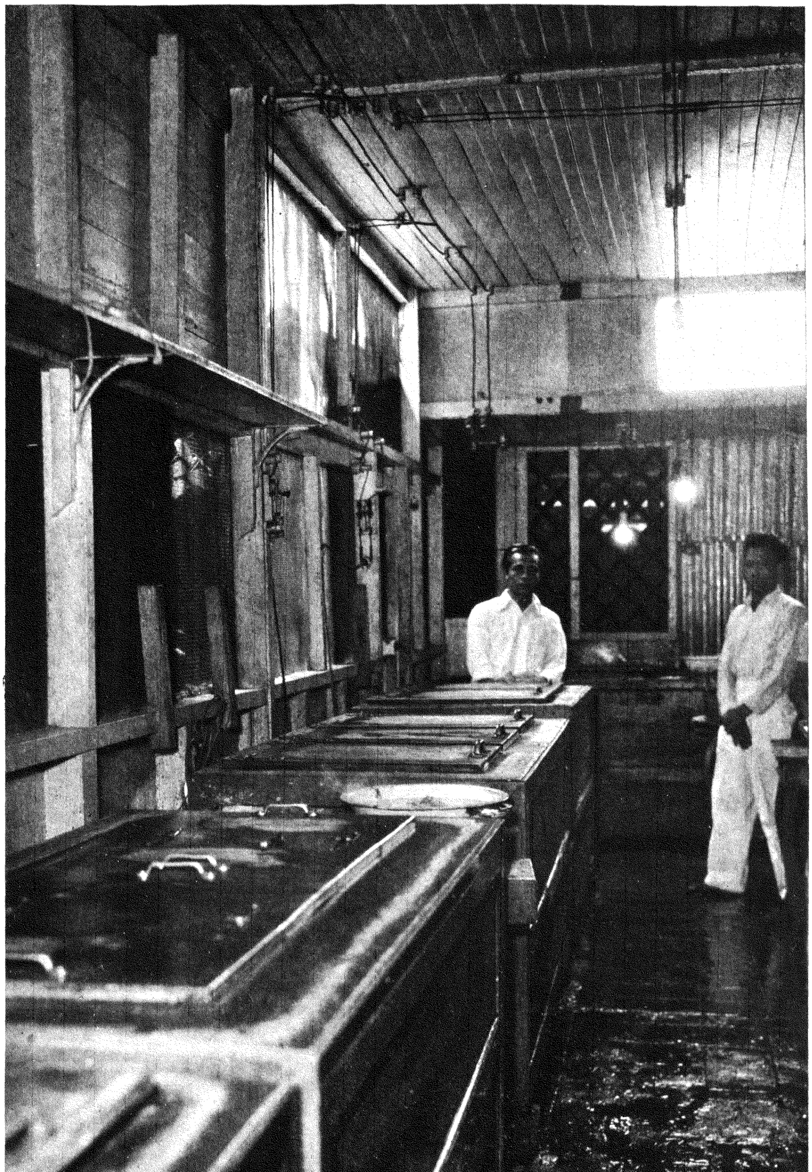

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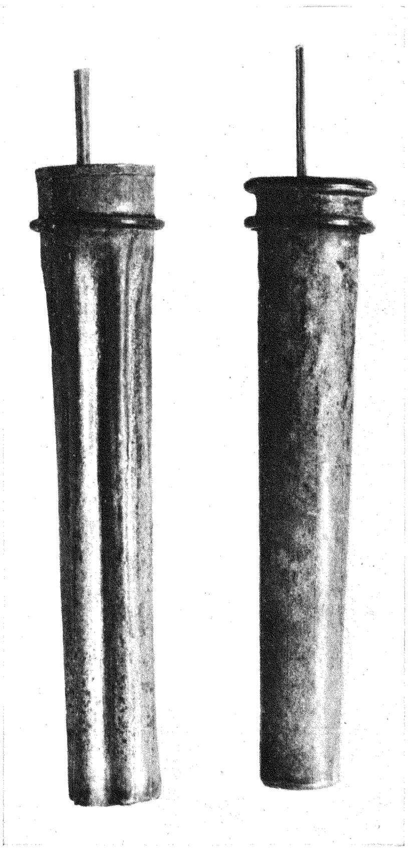

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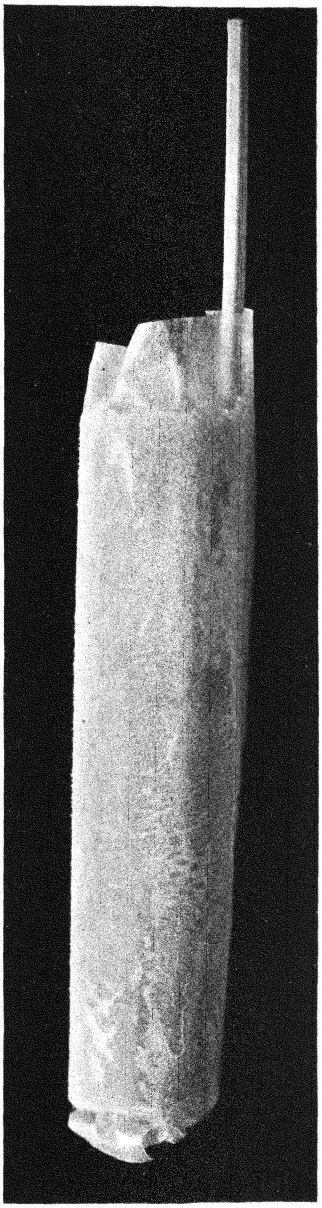

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PLATE 3.

THE TREATMENT OF HUMAN BERIBERI WITH CRYSTALLINE ANTINEURITIC VITAMIN

By A. J. HERMANO

Of the Bureau of Science, Manila

and

FROILAN EUBANAS

Of the Bureau of Health, Manila

Beriberi occurs principally in countries of the Far East; such as, the Philippines, Japan, China, Siam, India, Dutch East Indies, and the Federated Malay States. In these countries the diet of the masses consists largely of rice.

Beriberi is not confined entirely to countries of rice-eating populations, because researches on nutrition have shown that it is a deficiency disease, which may occur wherever the diet of people is lacking in vitamin B_1.

Studies on the etiology and treatment of adult and infantile beriberi in the Philippines have been made by Herzog,(1) Chamberlain et al.,(2) Albert,(3) L. Guerrero,(4) Andrews,(5) Williams and Saleeby,(6) M. Guerrero,(7) Saleeby,(8) and Chamberlain.(9)

Beriberi has been classified into two well-marked types, the dry and the wet, according to their symptoms and manifestations. The dry type is characterized clinically by great wasting and anæsthesia of the skin, which finally results in paralysis of the limbs. The wet type manifests excessive œdema, which may affect the trunk, limbs, and extremities. In cases with excessive œdema the heart usually becomes enlarged, and heart failure may result.

Various theories have been advanced as to the causes of beriberi, but the concensus of most authorities on nutrition is that beriberi is a deficiency disease and is caused by a lack of vitamin B_1.

Andrews(5) concluded that the high death rate of infants in the Philippines in 1912 was due primarily to the quality of the mother's milk. He recommended, as a prophylactic measure, the use of unpolished rice for pregnant women of the poorer

classes. Albert[3] classified infantile beriberi in three types; the cardialgic, aphonic, and pseudomeningitic. As a result of his studies on infantile beriberi based on 514 cases he concluded that infantile beriberi is a true deficiency disease. Other clinicians and investigators, like L. Guerrero,[4] Chamberlain,[9] Williams and Saleeby,[6] and M. Guerrero,[7] have used to a considerable extent the extract of rice polishings in the treatment of infantile beriberi. The extract proved to be a beneficial and efficient prophylaxis. Saleeby[8] treated human beriberi with marked results by the use of autolyzed yeast extract.

According to the information we have received from Dr. E. M. Nelson, Protein and Nutrition Division, Bureau of Chemistry and Soils, Washington, D. C., Dr. B. C. Jansen, of Amsterdam, has expressed the opinion that man is probably fully protected from beriberi when he consumes food that will provide 200 international units of antineuritic vitamin per day. In the standardization[10] of the Bureau of Science tikitiki extract, we found that one teaspoonful gives approximately 80 international units of vitamin B_1. The Bureau of Science tikitiki extract[11] is a concentrated aqueous extract of rice polishings (1 cc of extract corresponds to 14.5 g rice bran). It is used in large quantities by the puericulture centers, Bureau of Health, to combat or eradicate infantile beriberi in the Philippine Islands.

According to Table 1, the mortality from beriberi in the Philippines for the ten years 1924–1933 was 187,808, and about

TABLE 1.—*Deaths from beriberi in the Philippine Islands for the years 1924–1933.*

Year.	Manila (residents only.)			Provinces, including transients in Manila.			Total.		
	Infants.	Adults.	Total.	Infants.	Adults.	Total.	Infants.	Adults.	Total.
1924	577	23	600	12,612	5,795	18,407	13,189	5,818	19,007
1925	558	29	587	12,936	5,019	17,955	13,494	5,048	18,542
1926	495	31	526	13,532	5,151	18,683	14,027	5,182	19,209
1927	258	30	288	12,317	4,470	16,787	12,575	4,500	17,075
1928	340	28	368	11,951	4,464	16,415	12,291	4,492	16,783
1929	519	33	552	14,622	5,051	19,673	15,141	5,084	20,225
1930	286	40	326	16,199	5,049	21,248	16,485	5,089	21,574
1931	173	23	196	14,845	4,497	19,342	15,018	4,520	19,538
1932	200	22	222	13,102	3,849	16,951	13,302	3,871	17,173
1933	196	10	206	14,524	3,952	18,476	14,720	3,962	18,682
Total	3,602	269	3,871	136,640	47,297	183,937	140,242	47,566	187,808

74.67 per cent of those that die of beriberi are infants. For this period the average yearly death rate for a population of 100,000 (infants and adults) was 156.75. The mortality from beriberi in the City of Manila has been reduced very appreciably from 600 in 1924 to 206 in 1933. This significant decrease is probably due to the various health activities and the extensive use of tikitiki extract in Manila.

Since the first publication on the existence of an antineuritic vitamin many attempts have been made to prepare concentrated products and to isolate this vitamin from various materials, such as rice polishings, yeast, wheat germs, and mongo beans (*Phaseolus aureus*). Some investigators claimed to have produced or isolated an antineuritic vitamin in pure crystalline form possessing the therapeutic properties of vitamin B_1. Prominent among these may be mentioned Seidell,(12) Jansen and Donath,(13) Levene,(14) Kinnersley et al.,(15) Odake,(16) Cowgill,(17) and Seidell and Smith.(18) In recent years Williams and coworkers(19) published several papers and reported their method for preparing larger yields of the crystalline antineuritic vitamin.

The material employed in this preliminary report was the crystalline vitamin B_1 hydrochloride prepared from rice polishings by Williams and coworkers.(19)

Dr. R. R. Williams kindly sent to the Bureau of Science 100 milligrams of the crystalline vitamin B_1 hydrochloride to be tested on human beriberi. A sterilized solution of 1 milligram per cubic centimeter was prepared in vials with rubber cap. The solution was given by intramuscular injection when the patients came to the clinic.

Ten patients were treated in the clinic of the Walled City puericulture center, and two others who were patients in the Philippine General Hospital. The clinic patients were instructed to follow their regular diet, and not to eat rice polishings, mongo, (*Phaseolus aureus*), or other foodstuffs rich in vitamin B_1. The results of treating human beriberi with this preparation are given in the records of the following twelve cases.

CASE 1

Josefa Cañares, female, married, living at 54 Alvarado Street, interior 18, Tondo, Manila, para 10, complained for about five months of numbness in both legs and tips of the fingers, and also around the mouth. The numbness which began in the legs and toes, became worse during the last five months. In the beginning she felt pain in the calves and some peculiar pains around

the epigastric region. There was no vomiting. She had chest oppression on walking for some distance. Physically well developed and fairly nourished. Conjunctivæ were pale, and lung cavities were clear. Heart showed accentuation of the second pulmonic sound, and no evidence of increased dullness. Liver and spleen were negative. Legs showed no œdema, and skin was clean and dry. Knee jerk was sluggish.

March 17, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 19, 1934.—One cc injected into the left arm. Patient did not feel anything after the first injection.

March 20, 1934.—One cc injected into the right arm. Patient did not complain of anything unusual since the first injection.

March 27, 1934.—One cc injected into the left arm. Patient felt better, appetite was good, and the numbness was diminishing.

April 5, 1934.—One cc injected into the right arm. Patient felt much improved. She said that she could wear her slippers, which she could not do before. The numbness of the extremities and toes was diminishing. Calf pains have disappeared. Appetite was better, and her color improved. Knee jerk became stronger than in the first examination.

Patient did not come back for further treatment.

CASE 2

Gregoria Lim, 32 years, female, married, para 2, residing at Farola, Manila, complained of numbness at the tips of fingers, around the mouth, and at right thigh; also sensation of thickness and heaviness at the epigastric region. At times she felt a prickling sensation all over the body (not due to prickly heat). She experienced numbness in her right thigh for about six months and she was pregnant. The numbness at the tips of her fingers occurred right after the last delivery and lasted about 1.5 months. She was physically well-developed and fairly nourished; there was a cataract on the left eye. The right eye had been operated on previously. She had some dental caries. Heart and lungs were negative. Spleen and liver were negative. The knee reflexes were exaggerated. Skin was clean and dry.

March 19, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 20, 1934.—One cc injected into the left arm. Patient did not feel anything.

March 21, 1934.—One cc injected into the right arm. The numbness at the fingers and around the mouth was diminishing.

March 22, 1934.—One cc injected into the left arm. There was slight pain at the site of injection.

March 28, 1934.—Patient was injected with 1 cc into the right arm. Patient said that the numbness in finger tips and mouth disappeared. The prickling sensation all over the body also disappeared. She still had the numbness at the right thigh though not so pronounced as before. Knee jerk was not very much exaggerated. She felt fully recovered from her troublesome complaints except the slight numbness in right thigh.

CASE 3

Macaria Garcia, 35 years, female, married, residing at 912 interior San Marcelino Street, Manila, para 4 (all living) complained for about a month of numbness in the legs and feet and also of numbness and a tingling sensation in the fingers. In her second delivery she had similar symptoms but they were not so bad as at the present time. At times she felt chest oppressions. She was physically well developed and fairly nourished. The chest and lungs were clear but she was anæmic with face slightly puffy. Heart was apparently negative. Liver and spleen were negative. The knee reflex was absent. There was flabbiness in the muscles of the legs with signs of muscular atrophy. The skin was dry and fairly clean.

March 20, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 22, 1934.—One cc injected into the left arm. Patient made no complaints.

March 23, 1934.—One cc injected into the right arm. Patient did not feel any sign of relief. She appeared brighter, however, and face was not puffy in appearance. Knee jerk was absent.

March 24, 1934.—One cc injected into the left arm. Patient had no other signs of improvement.

From March 25 the patient did not report to the clinic and hence further observations could not be made.

CASE 4

Nicolasa Carumba, 37 years, female, married, para 7 (3 living), residing at 1019 Georgia Street, Malate, Manila, complained for about three months of numbness in legs. At times she felt some formications at thighs, and had chest oppressions. She was physically a well-developed and fairly nourished individual. Chest, heart, and lungs were negative. Liver and spleen were negative. Knee reflexes were slightly exaggerated in the right leg though less so in the left. The skin was clean and dry.

March 21, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 22, 1934.—One cc injected into the left arm. Patient felt nothing unusual.

March 26, 1934.—One cc injected into the right arm. Chest oppression and formications at thighs disappeared. She felt only numbness in the legs although this had slightly diminished. Reflexes were the same as at the first examination.

March 27, 1934.—One cc injected into the left arm. She felt very much improved. Appetite was good, and she could sleep better than on previous nights. Numbness in the legs was still present.

March 28, 1934.—One cc injected into the right arm.

From March 29 the patient did not report to the clinic and hence further observations could not be made.

CASE 5

Julia Ramelio, 21 years, female, married, residing at 36 Alfredo Street, Sampaloc, Manila, para 1, complained for 1.5 months of numbness in both legs and feet, around the mouth, and of a feeling like a constricting band around the epigastric region. She had at first chilliness and fever for a day, and subsequently numbness in both legs. When she was still pregnant she had frequent attacks of pain in calves. The symptoms gradually became worse until she felt numbness around her mouth. She was physically well developed, fairly nourished, anæmic, but a walking patient. Head and neck were negative. Chest and lungs were clear. Heart showed accentuation of the second pulmonic sound. No murmurs were heard in other valvular areas. Spleen and liver were negative. Knee reflexes were absent. There was slight œdema in the right leg.

March 23, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 24, 1934.—One cc injected into the left arm. Patient did not have any complaints.

March 26, 1934.—One cc injected into the right arm.

March 27, 1934.—One cc injected into the left arm.

March 31, 1934.—One cc injected into the right arm. Patient complained only of slight numbness in the legs and feet. She had no numbness at the mouth; occasionally felt constriction in epigastric region. She felt stronger and had a better appetite. Œdema disappeared.

From March 31, 1934, she did not report to the clinic for further observation.

CASE 6

Maria Fernandez, 30 years, female, mother of 5 children, 3 of whom died (2 with symptoms of beriberi). Of the living children, 1 was 9 years old and the other was 6. The patient was actually in the ninth month of pregnancy. She was complaining of numbness in the tips of the fingers, sensation of formications at the lower extremities (calves and feet), and thickness around the mouth. She also complained of weakness and tenderness of the muscles of legs and frequent palpitation. The symptoms were felt by the patient since February, 1934. She was physically a well-developed and fairly nourished individual. Head and neck were negative. Lungs were clear. The heart showed no signs of abnormality. Liver and spleen were negative. There was marked diminution of the knee reflex. There was slight œdema in the malleoli region.

March 24, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 25, 1934.—One cc injected into the left arm.

March 27, 1934.—One cc injected into the right arm. Tenderness in the muscles of the legs was disappearing. She felt stronger and better.

March 28, 1934.—One cc injected into the left arm. Œdema at the malleoli disappeared. Patient felt much stronger and appetite was good. Knee jerk was still sluggish.

March 31, 1934.—One cc injected into the right arm. The numbness in the lower extremities was improving. Knee reflexes were slow. The tenderness in muscles of legs improved.

April 3, 1934.—One cc injected into the right arm.

April 4, 1934.—One cc injected into the left arm. She had still some numbness in the fingers. She ate well and felt stronger and very much improved.

April 5, 1934.—One cc injected into the right arm.

April 6, 1934.—Patient did not report again for further treatment.

CASE 7

Remedios Francisco de Flores, 24 years old, married, residing at 35 Plaza McKinley, Walled City, Manila, complained of numbness of the upper and lower extremities. Her first child suffered from a disease diagnosed by a physician as chronic infantile beriberi. The infant recovered. The actual symptoms were felt by the patient fifteen days after delivery. She felt weakness and tenderness in the muscles of the extremities. She also complained of palpitation and an uneasy sensation in the abdomen. She was physically well developed. Lungs and heart were apparently negative. Liver and spleen were negative. Patellar reflex was very much diminished.

March 24, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm. There were no after-effects.

March 26, 1934.—One cc injected into the left arm.

April 3, 1934.—One cc injected into the right arm. Patient felt a slight improvement.

April 4, 1934.—One cc injected into the left arm. Patient felt better and claimed improvement since first injection.

April 5, 1934.—Patient did not report again for further treatment.

CASE 8

Isabel To, 23 years, female, married, residing at 191 Palomar, Tondo, Manila, para 4 (1 having died of infantile beriberi, or "taon", according to her physician). The remaining 3 were well and healthy. She complained of numbness in the feet and legs, formication of fingers, chest oppression, and fatigued easily on walking. Duration of these complaints was two months. She also felt a thickening sensation around her mouth and about the face. Every morning she felt pain in the calves and feet. She was physically well developed and a walking patient. Chest and lungs were clear. Heart showed slight accentuation of second pulmonic sound. Liver and spleen were negative. Knee jerks were absent. Skin was clean and dry.

March 26, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 27, 1934.—One cc injected into the left arm.

March 28, 1934.—One cc injected into the right arm. She felt that the numbness was much diminished and the formications at fingers were disappearing. She did not complain much of chest oppression, and she could walk for longer distance without easily becoming fatigued.

April 2, 1934.—One cc injected into the left arm. She felt better than the last observation.

From April 3, the patient did not report to the clinic for further observation.

CASE 9

Emiliana B. de Julio, 34 years, female, married, residing at 727 Sanchez Street, Binondo, Manila, para 8; 3 children died of infantile beriberi according to her physician. She was actually in the eighth month of pregnancy. She complained of numbness in the tips of the fingers and toes, and also had dull pains in the loins for about one month. She was a physically well-developed and well-nourished individual. Head and neck were negative. Chest, heart, and lungs were negative. Liver and spleen were negative. The knee jerk was normal, and the skin was clean and dry.

March 26, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 27, 1934.—One cc injected into the left arm. The patient was better, and the numbness at tips of fingers diminished.

March 28, 1934.—One cc injected into the right arm. Patient felt better.

April 2, 1934.—One cc injected into the left arm. The numbness disappeared according to the patient. She felt better and had a good appetite and could sleep well.

April 3, 1934.—One cc injected into the right arm.

April 4, 1934.—One cc injected into the left arm.

April 5, 1934.—One cc injected into the right arm. The complaint of numbness practically disappeared.

April 6, 1934.—Patient did not report again to the clinic for further treatment.

CASE 10

Juana de la Cruz, 29 years of age, was a widow. Her illness, which began six months previously, was manifested by the gradual loss of body weight and general debility. Upon consultation she complained of pain and oppression of the chest accompanied by difficult breathing. There was a sensation of fullness and dull pain of the hypogastrium. There was numbness of both the upper and lower extremities, and numbness and formication of both lips. Tachycardia was present, and the patient was nervous. She complained of insomnia and loss of appetite. Hyperreflex of the knee jerk was observed.

April 2, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm. There was no improvement.

April 4, 1934.—One cc injected into the left arm. There was no improvement.

April 6, 1934.—One cc injected into the right arm. The patient showed sign of improvement, by the slight disappearance of numbness of the upper and lower extremities. She now had fair sleep and appetite.

April 9, 1934.—One cc injected into the left arm. She had marked improvement with the disappearance of chest oppression and hypogastric dullness.

April 11, 1934.—The patient did not report again for further observation.

CASE 11

Carmelita Yumol, female, 2 months old, entirely breastfed, was admitted to the pay section of Philippine General Hospital on June 29, 1934, in a very serious condition, with complaints from the parents of persistent crying, difficult breathing, and cyanosis of face. Child had not received any tikitiki extract since birth. The present illness started early in the morning and she was brought to the hospital at about noon. Physical findings revealed cyanosis of lips, persistent crying, and a rather muffled heart sound. Child semistuporous.

Treatment.—Five-tenths cc of vitamin B_1 solution containing 0.5 mg was given by intramuscular injection. Tikitiki extract (5 cc every 15 minutes) was given and also a hypodermic injection of 50 cc isotonic glucose solution. About eight hours after admission, the baby showed marked improvement and recovered rapidly soon after.

Diagnosis.—Cardiac infantile beriberi. Discharged July 3, 1934.

CASE 12

Antonio Banigued, male, 7 months old, entirely breastfed, was admitted on May 29, 1934, to charity ward, Philippine General Hospital. Present illness began three days previously as vomiting after nursing, soon accompanied by gradual weakening of voice and restlessness. On the third day child developed tympanism, difficult breathing, and staring of eyes. This attack was repeated several times in the morning of admission. Physical findings—accentuated second pulmonic sound and exaggerated knee jerk.

Treatment.—One cc of vitamin B_1 solution containing 1 mg was given twice by hypodermic injection. On the next day the child appeared apparently normal. An X-ray examination of the heart showed no enlargement.

DISCUSSION AND SUMMARY

Crystalline antineuritic vitamin was used in treating cases of human beriberi, both adult and infantile. It was given by intramuscular injection to ten adults and two infants.

The treatments as described in cases 1, 2, 5, 7, 8, 9, and 10 showed that the crystalline antineuritic vitamin gave very promising indications of curing human beriberi.

Cases 3 and 4 showed good indications of being cured with the exception that the numbness in the legs was still present when the patients reported at the clinic for the last time. However, each patient was given another injection, but none came back for further observation.

In case 6 the patient was relieved of her complaints with the exception of some numbness at her fingers. She was given another injection and did not report again at the clinic for further observation.

Cases 11 and 12 were diagnosed at first as having infantile beriberi. The cure could not be attributed mainly to the administration of the crystalline antineuritic vitamin since the patients were given tikitiki extract.

ACKNOWLEDGMENT

The authors wish to thank Dr. R. R. Williams and coworkers, of Columbia University, New York City, for the valuable sample of antineuritic vitamin used in these tests, and Dr. Moises Abad for his kindness in administering injections to two patients in the pediatric ward of the Philippine General Hospital. They are also indebted to Dr. José Guidote, section of vital statistics, Bureau of Health, Manila, for data on the mortality from beriberi in the Philippine Islands.

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THE NITROGEN DISTRIBUTION AND CARBOHYDRATE PARTITION IN PHILIPPINE RICE BRAN [1]

By JOAQUIN MARAÑON and LUZ COSME

Of the Bureau of Science, Manila

Due to its varied uses and highly nutritive properties Philippine rice bran, locally known as "tikitiki" or "darak," has been the subject of study by several investigators.(1 to 5) Considering, therefore, its importance as a foodstuff, any further investigation relative to its properties and chemical composition should be of value.

This paper gives the results of a study of the nitrogenous and carbohydrate constituents of Philippine rice bran. A preliminary notice of our study of the nitrogen distribution in rice bran was published recently.(1)

The rice bran used in this investigation was obtained directly from a rice mill on Azcarraga Street, Manila. It was a high-grade bran that contained no rice hulls, mold spores, insects, or other foreign admixture. In order to avoid any appreciable deterioration of the bran, due to storage, portions of the fresh bran were taken immediately after milling for the various analytical determinations.

TABLE 1.—*Composition of Philippine rice bran.*

Constituent.	Rice bran.	
	Air dried.	Moisture free.
	Per cent.	*Per cent.*
Moisture	11.65	----------
Fat (ether extract)	19.81	22.42
Protein (2.264 per cent nitrogen)	12.50	14.15
Ash	10.41	11.78
Crude fiber	6.32	7.15
Carbohydrates (by difference)	39.31	44.50
Total	100.00	100.00

The composition of the bran (Table 1) was determined in the usual manner.(6) The Gunning method, modified to include the

[1] Read before the Third Philippine Science Convention, Manila, February 28, 1935.

nitrogen of nitrates,(7) was followed for the total nitrogen determination.

NITROGEN DISTRIBUTION

Experimental procedure.—The following methods were used for determining the different kinds of nitrogen.

Nonprotein nitrogen.—A quantity (15 grams) of bran was repeatedly extracted with ammonia-free water. The clear aqueous filtrate was boiled with a few drops of acetic acid, cooled, filtered, and made up to a definite volume. Two aliquot portions of this protein-free aqueous extract were taken for the duplicate nitrogen determinations according to the method recommended by Pucher, Leavenworth, and Vickery.(8)

The remainder of the extract was used for the nitrogen distribution of the nonprotein nitrogen.

Data on the distribution of the nonprotein nitrogen into acid amide, humin, basic, and nonbasic (Table 2) were obtained in accordance with the method of Hausmann as modified by Jodidi.(9)

Protein nitrogen.—This was determined directly from the rice bran using Stutzer's method.(6)

The results of the protein-nitrogen distribution (Table 2) were calculated by subtracting the percentages of the various kinds of nonprotein nitrogen (Table 2) from the corresponding percentages of the nitrogen products obtained from the bran after acid hydrolysis (Table 3).

Water-soluble nitrogen.—A sample (10 grams) of bran was placed in a bottle with 500 cubic centimeters of distilled water and shaken in a machine for two hours. The clear supernatant liquid was decanted from the sediment. This treatment was repeated twice and the combined aqueous liquids filtered. The residue was then placed on the filter used for the decanted liquid and washed thoroughly. The filtered aqueous extract was diluted to a definite volume. Two aliquot portions of the extract were taken for duplicate nitrogen determinations (method of Pucher, Leavenworth, and Vickery).

Free amino-acid nitrogen.—From the remaining portion of the aqueous extract of bran prepared as above described, the amino-acid nitrogen was determined following Van Slyke's method.(10)

The nitrogen partition in the bran after acid hydrolysis (Table 3) was carried out according to Jodidi and Moulton's procedure.(11)

Results.—Data on the various kinds of nitrogen contained in Philippine rice bran are given in Tables 2 and 3.

TABLE 2.—*Nitrogen distribution in Philippine rice bran.*

Kind of nitrogen.	Rice bran.		Results calculated on basis of total nitrogen.[a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Nonprotein	0.229	0.259	11.439
Protein	1.771	2.005	88.561
Total	2.000	2.264	100.00
Nonprotein:			
Acid amide	0.034	0.038	1.678
Humin	0.019	0.021	0.927
Basic	0.027	0.031	1.369
Nonbasic	0.149	0.169	7.465
Total	0.229	0.259	11.439
Protein:			
Acid amide[b]	0.154	0.174	7.685
Humin[b]	0.049	0.055	2.429
Basic[b]	0.300	0.340	15.018
Nonbasic[b]	1.268	1.436	63.429
Total	1.771	2.005	88.561
Water soluble	0.391	0.442	19.523
Nonprotein	0.229	0.259	11.439
Free amino-acid	0.153	0.173	7.641

[a] Calculated on the moisture-free sample containing 2.264 per cent nitrogen.
[b] Calculated.

TABLE 3.—*The distribution of nitrogen in Philippine rice bran.*

[After acid hydrolysis of the bran.]

Kind of nitrogen.	Rice bran.		Results calculated on basis of total nitrogen.[a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Acid amide	0.188	0.212	9.364
Humin	0.068	0.076	3.357
Basic	0.327	0.371	16.387
Nonbasic	1.417	1.605	70.892
Total	2.000	2.264	100.000

[a] Calculated on the moisture-free sample containing 2.264 per cent nitrogen.

As shown by the data (Table 2) the protein content of the bran is about eight times the nonprotein. Both the protein and the nonprotein nitrogen are largely nonbasic, though they also contain noteworthy amounts of basic and acid-amide nitrogen.

The results we have obtained with rice bran, which contains the rice embryo, agree in general with those of Hamada(12) and Jodidi.(13) Hamada found in the protein of the rice embryo more mono-amino (nonbasic) nitrogen than diamino (basic) nitrogen. According to the investigations of Jodidi the protein of the rice kernel has more nonbasic than basic nitrogen.

A large proportion of the water-soluble nitrogen is nonprotein, which consists principally of free amino-acid nitrogen.

CARBOHYDRATE PARTITION

Experimental procedure.—The different kinds of carbohydrates were determined in accordance with the following methods.

Sugars.—In preparing the solution for sugar analysis, we used the directions given by the Official Agricultural Chemists for grains and stock feeds.(7) The reducing and nonreducing sugars were analyzed by means of Fehling's solution. Munson and Walker's directions(7) were used for the precipitation of the cuprous oxide, which was estimated by the volumetric thiosulphate method.(7)

Starch.—The starch was determined by the diastase method with subsequent acid hydrolysis.(7)

Pentosans.—For this analysis the official method for grains and stock feeds was used.(7)

Dextrins and hemicellulose.—The methods described by Gerhardt for the determination of these two complex carbohydrates in the Grimes apple(14) were followed.

Gums.—A sample (25 grams) was extracted repeatedly with 20 per cent alcohol. The extract was concentrated to a syrupy consistency by distillation under reduced pressure. To the residue a sufficient quantity of 95 per cent alcohol was added to precipitate the gums. The gummy substances were allowed to settle overnight and the supernatant liquid decanted. The gums were then washed several times with a small quantity of 80 per cent alcohol, dried, and weighed.

TABLE 4.—*The partition of carbohydrates in Philippine rice bran.*

Kind of carbohydrate.	Rice bran.		Results calculated on basis of total carbohydrates.[a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Reducing sugars	0.40	0.45	0.87
Nonreducing sugars	5.32	6.02	11.66
Starch	21.34	24.16	46.76
Dextrins	0.46	0.52	1.01
Hemicellulose	0.73	0.83	1.61
Pentosans	8.03	9.09	17.58
Crude fiber	6.32	7.15	13.85
Gums	2.57	2.91	5.64
Undetermined	0.46	0.52	1.02
Total	45.63	51.65	100.00

[a] Calculated on the moisture-free sample containing 51.65 per cent total carbohydrates (including crude fiber).

Results.—Table 4 gives data on the partition of carbohydrates in Philippine rice bran. As shown by these results the starch content is rather high and amounts to 24.16 per cent calculated on the moisture-free sample. This represents 46.76 per cent, computed on the basis of the total carbohydrates of the oven-dried bran. Other carbohydrates, which were present in amounts ranging from above 5 to 17 per cent, were pentosans, crude fiber, nonreducing sugars, and gums.

SUMMARY

High-grade Philippine rice bran that contained no hulls was analyzed and the composition ascertained. The bran contained a considerable amount of carbohydrates (44.50 per cent). The nitrogen in the bran (2.264 per cent) corresponds to 14.15 per cent protein by calculation (Table 1).

Investigation of the nitrogen distribution showed that the major portion of the nitrogenous substances in rice bran consisted mostly of protein, which is composed largely of nonbasic nitrogen.

The partition of carbohydrates in rice bran was also determined. The bran had a rather high starch content (24.16 per cent) and, in addition, contained small amounts of other carbohydrates, such as pentosans, nonreducing sugars, gums, and also crude fiber.

292685——10

The results obtained in this investigation are useful in that the experimental data give in detail the characteristics of both the nitrogenous and carbohydrate constituents of Philippine rice bran.

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THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, P. I.

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The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 302, Manila, P. I., or to any of the agents listed below.

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CONTENTS

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 57, NO. 3 JULY, 1935

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1935

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 57 JULY, 1935 NO. 3

THE METHYLENE BLUE REDUCTION TEST: ITS EFFICIENCY AND INTERPRETATION UNDER PHILIPPINE CONDITIONS.[1]

By JOSÉ B. UICHANCO

Of the College of Veterinary Science, University of the Philippines, Manila

ONE TEXT FIGURE

Sanitarians have long recognized that the bacterial content of milk is one of the most important criteria of the quality and cleanliness observed in its production and subsequent handling. Several methods have been devised for estimating the bacterial content of milk. Among the bacteriologic methods described by the American Public Health Association is the "methylene blue reduction method," also known as the "reductase test."

This test is a biochemic one and is based on the fact that the color imparted to milk by a small quantity of methylene blue will in time disappear, due, mainly, to the action of bacteria present. Formerly it was believed that there was a more or less direct relationship between the rate of decolorization and the number of bacteria; that is, the fewer the bacteria, the longer the time necessary for decolorization. Later researches, however, revealed that this is only partially true.

Due to the simplicity and ease of applying and interpreting the methylene blue reduction test, together with the comparatively simple equipment required, should this test be found efficient under local conditions, it is likely that it will be as widely used here as it is in Europe and, to some extent, in the United States and Canada.

[1] Read at the Third Philippine Science Convention, February 27, 1935.

I acknowledge with thanks the kindness of Dr. Angel K. Gomez, assistant dean and head of the Department of Pathology and Bacteriology, College of Veterinary Science, in extending laboratory and transportation facilities without which this work would have been seriously handicapped.

REVIEW OF THE LITERATURE

About ten years after Caro's discovery (Hall, 1921) of methylene blue in 1876, that dye gained popularity as an indicator of biochemic reduction through Ehrlich's (1885) study of "the combined velocity, capacity and intensity factors of biological reduction." In 1894 Duclaux studied the reduction of dyes with special reference to milk and found that milk subjected to bacterial action becomes reducing. Neisser and Wechsberg in 1900 suggested that the reduction of methylene blue might be used as an indication of the bacterial content of milk.

Barthel and Orla-Jensen originally prepared the methylene blue solution by suitable dilutions of a saturated alcoholic solution of the dye. Later, they recommended (1912) the use of prepared tablets containing a standard amount of methylene blue. Russell, Morrison, and Ebling (1925) cited Weber, who found that the methylene blue powder obtained from different sources varies considerably in strength, while the prepared tablets are sufficiently uniform for practical purposes. The "Standard Methods" (1934) recommends the use of prepared tablets. Thus the necessity of expensive chemical balances is eliminated and all workers are enabled to use a uniform reagent and to obtain comparable results. The standard concentration of the dye used in this test is 1 part of dye to 200,000 parts of milk.

Up to a few years ago the conception of the phenomenon of methylene blue reduction in milk was that it was due to an enzyme, reductase, hence it was called the "reductase test." Jensen (1907) concluded that the peroxidase of cow's milk comes exclusively from the mother cow, presumably from the fodder; the catalase, partly from the leucocytes of the mother cow and to a large extent from the microörganisms; but that the reductase of fresh milk ("Aldehydkatalase") comes exclusively from the fat globules ("Milchkügelchen"). However, Trommsdorf (1909) found that freshly drawn milk free from bacteria contains no reductase. Subsequently, Rullmann (1910) in a study of eighty-one aseptically drawn milks concluded that reductase, hydrogenase, and other enzymes found in cow's milk

are of bacterial origin. Burri and Kürsteiner (1912) also concluded that, as a rule, besides bacteria there is no other reducing factor in normal raw milk. Fred (1912), moreover, found that bacterial development and time of reduction are related inversely to a certain degree and that the reductases are formed only by the growth of microörganisms and are therefore absent in milk when first drawn. He also thinks that very probably both intracellular and extracellular products take part in the reduction.

However, the phenomenon of dye reduction in sterile milk (Barthel, 1917), and other bacteriologic media (Dubos, 1929), cannot be satisfactorily explained by the bacterial enzyme theory of reduction. Recent studies (Thornton and Hastings, 1929) on the potential-time curves further demonstrated the weakness of this theory. Barthel and, later, Hastings (1919) suggested that the reduction of methylene blue might be due to some constituents of the milk.

Barthel (1917) believed that the disappearance of methylene blue in milk takes place in two stages; namely, (*a*) the removal of the dissolved oxygen by the bacteria and (*b*) the reduction of the dye by constituents of the milk. Thornton and Hastings (1929, *a;* 1930) confirmed this theory of Barthel and also found that the time taken for the first stage may be long, while for the second stage it is usually short. They also confirmed the findings of Hastings and his associates (1922) that a preliminary shaking of the milk does not materially affect reduction time, contrary to the findings of Lojander (1925), which show that shaking the milk thirty times results in a lengthening of the reduction times. The findings of Marshall (1902) indicate that there are some variations in the oxygen content of different milks as received at the milk plant. However, Thornton and Hastings (1930), judging from their experiments, believe that the differences in the oxygen content of milk samples produced in the ordinary way apparently will not introduce serious inaccuracies into the test. On the other hand, they assumed that the two important inaccuracies of this test are due to (*a*) the rate of oxygen uptake by the milk bacteria and (*b*) the removal of bacteria from the body of the milk by the rising butter fat. The original literature gives more-detailed information on these points.

Within the last few years the phenomenon of dye reduction was studied from an entirely different angle since Gillespie (1920) showed that the reducing intensity of bacterial cul-

tures is measurable by potentiometric methods. The recent studies of Clark and his associates (1928), Coulter (1928), Thornton and Hastings (1929), Cohen (1931), Frazier and Whittier (1931), Fay and Aikins (1932), and others have necessitated a revision of the older views as to the meaning of dye reduction in milk, this time in terms of the electronic concept of oxidation-reduction phenomenon.

Hewitt (1933) published an interesting review of the recent advances made in the study of oxidation-reduction reactions. In the light of the present knowledge, biologic oxidation reactions are considered as "electronic rearrangements" or "electronic migrations" involving exchanges of electric charges. The migration of hydrogen or oxygen atoms is regarded as "merely incidental to the maintenance of electrical neutrality." Since oxidation and reduction reactions involve exchanges of electric charges, they readily lend themselves to an exact quantitative study by electrode potential measurements. In terms of physical chemistry, "the more highly oxidized a substance is the higher will be the electrode potential, and the more reduced, the more negative." The intensity level of the oxidizing or reducing functions of substances is determined by the readiness with which they part with, or take up, electrons. The expression "electrode potential," or Eh, is a measure of intensity level and is "dependent on the ratio of oxidized and reduced forms of the substance studied and not on their absolute quantities." The most reliable method of measuring Eh is the direct electrometric determination of the potential. However, certain dyes, like methylene blue, which change color at different ranges of Eh, may also be used as oxidation-reduction potential indicators. Methylene blue has always been considered as the indicator par excellence in the reduction test for milk.

Fay and Aikins (1932) have aptly said, "The methylene blue reduction test as it is used today is one of the most practical tests for determining the quality of milk. Although the early conceptions of biological processes have been completely reorganized, the selection of the dye and the concentration employed have not been changed by a more fundamental understanding of the factors involved."

Orla-Jensen (1931, pp. 184–191) states that this test is widely employed in milk-control work in Scandinavian countries. According to Mudge (1927), this method has found considerable support also in other parts of Europe. Fay (1930)

states that this test has met with great popularity in the United States. Thornton and his associates (1934) report that the methylene blue reduction test is used extensively with considerable success in Alberta Province, Canada, and that it measures the bacterial content of a great many of the milks arriving in Edmonton more accurately than does the plate count.

In practice the methylene blue reduction test is divested of some technicalities in order to make it simpler and more practical. Instead of the 10-cc pipettes, 10-cc dippers and graduated test tubes have been introduced for measuring the milk samples. Sterility of the apparatus and reagent is not considered by some as essential. Thornton and Hastings (1930) consider the 10-cc dipper sufficiently accurate; they have shown (1929, *a*) that a concentration of 1 part dye to 200,000 parts milk gives approximately the same results as a dye concentration of 1: 100,000. They also concluded that, in routine work, sterility of the dipper or the dye solution is not necessary if the reduction times are not read after five and a half hours; also, any water fit for drinking can be used as a solvent for the dye. Fay (1930) also came to the conclusion that the various modifications designed to simplify the test do not seriously affect its interpretative value. However, he calls attention to the necessity of observing great care in measuring the methylene blue solution as gross errors in its measuring may impair the accuracy of the test.

The time required for decolorization in this test has been empirically correlated with the number of bacteria present, and according to Orla-Jensen (1931, pp. 184–191) the following scheme of classification is used in the Scandinavian countries:

Class I. Good milk, not decolorized in five and a half hours, developing as a rule, less than one-half million colonies per cc on agar plates.

Class II. Milk of fair average quality, decolorized in less than five and a half hours but not less than two hours, developing as a rule, one-half to four million colonies per cc on agar plates.

Class III. Bad milk, decolorized in less than two hours, but not less than twenty minutes, developing as a rule, four to twenty million colonies per cc on agar plates.

Class IV. Very bad milk, decolorized in twenty minutes or less, developing as a rule, over twenty million colonies per cc on agar plates.

In "Standard Methods" (1929), where the report of Bolling (1924) was cited, it is hinted that, under American conditions, the above classification is apparently working out fairly well.

So far as the writer is aware, there is no published work on this subject in the Philippines.

OBJECT OF THE PRESENT WORK

The object of the work here reported was to determine the efficiency of the methylene blue reduction test and the applicability of the Scandinavian method of interpretation of this test under local conditions. Carabao milk was used because the carabao is our principal source of milk in the provinces, where tests of this nature would be most applicable, owing to the absence of proper laboratory facilities. Moreover, the carabao's habit of wallowing in the mud, together with the all too prevalent neglect on the part of the milkman to observe sanitary precautions, are likely to result in milk contamination by forms of bacteria other than those normally found in cow's milk.

MATERIALS AND METHODS

Milk samples.—Carabao milk only was used in this experiment. The samples of milk were bought from different milkers in the barrios of Alabang and Cupang in the municipality of Muntinlupa. One hundred forty-two samples bought from 36 milkers were examined. They ranged in age from one to two hours at the time of the test. They were not refrigerated but were examined immediately upon arrival in the laboratory. From 8 to 12 samples were examined each time. The tests were performed twice a week.

Methylene blue solution.—Methylene blue tablets manufactured by the National Aniline and Chemical Company were used. Several 500-cc bottles, each containing 200-cc of glass-distilled water, were sterilized at 20 pounds for thirty minutes and then closed with sterile rubber stoppers. Several 300-cc beakers, covered with Manila paper, were also sterilized in the same way.

The day previous to the test about 50 cc of the sterile distilled water was poured into a sterile beaker and boiled and one methylene blue tablet dropped into it and dissolved. The remainder of the distilled water in the bottle was then added to the hot dye solution. This gave a 1:200 solution. When the solution had cooled, it was poured into the sterile bottle and tightly stoppered. A fresh solution of methylene blue was prepared for each batch of samples to be examined.

Apparatus.—Standard 1-cc (subcalibrated into hundredths of a cubic centimeter) and 10-cc pipettes were put in separate

metal containers. Standard Petri dishes were individually wrapped in paper. The test tubes were plugged with cotton. All of these were sterilized in the hot-air sterilizer at 175° C. for one hour. Several rubber stoppers for the test tubes were also wrapped in paper and sterilized with the dilution bottles at 20 pounds pressure for thirty minutes in the autoclave.

Medium.—The nutrient agar was prepared according to the standard method. Witte peptone and commercial agar (*gulaman*) were used. The agar was previously soaked and washed in distilled water and drained. The medium was clarified, dispensed in 10-cc amounts in test tubes, and sterilized at 15 pounds for twenty minutes. The pH value, after final sterilization, was 6.8.

EXPERIMENT

Each sample of milk was examined by the methylene blue reduction method and by the Petri plate, or standard plate method. In order to determine the efficiency of the reduction test, five such tests (*a*, *b*, *c*, *d*, and *e*) were performed at the same time from each sample. The object of this phase of study was to find out if replicate tests of the same sample will decolorize at the same time; if not, whether such variations will affect the interpretative value of the test. To ascertain whether the Scandinavian scheme of interpretation of this test will work well under local conditions, the standard plate method was also used with each sample. Since the standard plate method requires more time to perform, each sample was examined by that method first, followed immediately by the methylene blue reduction test. In this way the two tests were performed on each sample within five minutes of each other. Thus, the bacteria did not have much chance to multiply. These tests were all made in a closed room in order to minimize chances of contamination from outside sources. The technic employed was in accordance with the "Standard Methods" (1934).

STANDARD PLATE METHOD

The sample was shaken vigorously and then dilutions of 1 : 100, 1 : 1,000, 1 : 10,000, and 1 : 100,000 were made and plated. The dilution bottles were also vigorously shaken before each plating and further dilution. Ten cc of melted nutrient agar at a temperature of 40° C. was used for each Petri dish. The diluted milk sample and the medium in the Petri dish were thoroughly mixed and then allowed to harden. When the agar had solidified, the plates were inverted and incubated

at 37° C. for forty-eight hours. The dishes were piled in stacks of three, with about an inch space between piles. A water-jacketed type of incubator was used. The counts were made on plates containing from 30 to 300 colonies. The colonies were individually counted with the aid of a hand lens. Control plates were also incubated to check the sterility of the nutrient agar, glassware, and diluting fluid used.

THE METHYLENE BLUE REDUCTION TEST

By means of a sterile pipette, 10 cc of each sample of milk was placed in each of five sterile plugged tubes, with the necessary aseptic precautions. The sample bottle was shaken vigorously before drawing the sample. One cc of the dye was then added to each tube. The cotton plug was replaced by a sterile rubber stopper and the test tube inverted gently to mix the dye and milk thoroughly. The milk assumed a robin's egg blue color. No dye was added to an extra tube containing 10 cc of milk to serve as control. The time was recorded, and the tube immediately placed in a 37° C. water bath. The tubes were then transferred to separate containers and put in a 37° C. incubator. Observation was made at frequent intervals (not longer than five minutes) until the milk regained its normal color as compared with the control tube, when the time was again recorded. The samples that were about to decolorize were observed more closely so that the closest approximate time of decolorization could be recorded. In cases where the color did not disappear uniformly the tubes were inverted gently to mix the dye. When the color disappeared after mixing, the tube was discarded and the time recorded. If the color persisted the tube was again returned to the incubator for further observation. The incubator was always maintained at 37° C.

RESULTS AND DISCUSSION

THE EFFICIENCY OF THE METHYLENE BLUE REDUCTION TEST

Table 1 shows the efficiency of the methylene blue reduction test as performed on 142 samples of carabao milk, five parallel tests (*a*, *b*, *c*, *d*, and *e*) to each sample. Of the 21 samples belonging to class I, 18 decolorized simultaneously in replicate tests and are designated as "uniform samples." This gives a frequency of occurrence of 85.71 per cent. Only 3 samples, or 14.28 per cent, of the class I samples did not decolorize simultaneously and are designated "erratic samples." Samples

of classes II, III, and IV are similarly recorded. Of the 64 samples examined under class II, 62, or 96.87 per cent, were uniform samples and 2, or 3.12 per cent, were erratic. There were 47, or 97.91 per cent, uniform samples of the 48 class III samples and 1, or 2.08 per cent, erratic. There was no erratic case in the 9 class IV samples examined. The great difficulty experienced in obtaining samples belonging to class IV would not permit the examination of a greater number of samples.

The actual decolorization data of the erratic samples are also given. Column 9 gives the decoloration times of each of the five tubes in each sample in replicate tests. Examination of the entire column shows a variation of from one to ninety minutes between replicate tests of the same sample. However, despite these variations, all the tubes in the replicate tests for each sample, except those of sample S–78 of class III, decolorized within the decolorization time limit set for the class to which the sample belongs. In the case of sample S–78 no great injustice would probably be done to the milker if it were classified as class IV instead of class III. Thornton and Hastings (1930) found that except in very rapidly reducing milks it is difficult to read the end point, in many cases to within five and even ten and fifteen minutes, and that it was simply guess work after twenty-three hours. For the same reason Johns (1931) in his investigation disregarded variations of less than fifteen minutes. This difficulty was greatly obviated in the present study by comparing the samples tested with the control. However, the extra precautions observed notwithstanding, the end-point readings herein reported cannot be claimed to be accurate to the minute and for practical purposes a difference of five minutes in replicate tests can be regarded as insignificant. The mean and the deviation from the mean of each erratic sample are given in columns 10 and 11, respectively, for purposes of comparison.

The variation in reduction time for the replicate tests on the same sample of milk was calculated and recorded in columns 12 and 13 as standard deviation and coefficient of variability, respectively. Although the data for each sample from which these statistical constants were computed are rather inadequate (five), yet it will give us a better idea of the reliability of the test. For example, in the case of sample S–23, three times its standard deviation, 36, on either side of its mean, 252, will include all possible variates. The coefficient of variability ranges from 0.66 to 14.28 per cent.

TABLE 1.—*The efficiency of the reductase test.*

Class (Scandinavian method).	Samples examined.	Uniform samples.		Erratic samples.							Standard deviation.	Coefficient of variability.
						Decolorization data.						
		Samples	Frequency occurrence.	Samples.	Frequency occurrence.	Sample No.	Tube.	Decolorization time.	Mean.	Deviation from the mean.		
			Per cent.		*Per cent.*			*min.*	*min.*	*min.*		
							a	335		— 5		
							b	335		— 5		
						S-162	*c*	335	340± 3.37	— 5	10±2.13	2.94±0.627
							d	360		+20		
							e	335		— 5		
							a	365		—11		
							b	365		—11		
I	21	18	85.71	3	14.28	S-110	*c*	420	376± 6.61	+44	22±4.69	5.85±1.247
							d	365		—11		
							e	365		—11		
							a	384		— 2		
							b	384		— 2		
						S-1	*c*	389	386± 0.81	+ 3	2.45±0.52	0.66±0.140
							d	389		+ 3		
							e	384		— 2		

II	64	62	96.87	2	3.12	S-9	a	200	198 ± 0.81	+ 2	2.45 ±0.52	1.23 ±0.262
							b	200		+ 2		
							c	195		— 3		
							d	200		+ 2		
							e	195		— 3		
						S-23	a	270	252 ±12.14	+18	36 ±7.67	14.28 ±3.045
							b	180		—72		
							c	270		+18		
							d	270		+18		
							e	270		+18		
III	48	47	97.91	1	2.08	S-78	a	23	21 ± 0.68	+ 2	1.48 ±0.31	7.04 ±3.045
							b	23		+ 2		
							c	18		— 3		
							d	19		— 2		
							e	22		+ 1		
IV	9	9	100.00	0	0.00				0.00		0.00	0.00
For all classes	142	136	95.77	6	4.15							

In general the data obtained agree with the conclusions reached by Fay (1930) that the methylene blue reduction tests are characterized by a low degree of variability and in replicate tests the maximum and the minimum reduction time for each sample are relatively close together. Fred and Chappelear (1911) observed a remarkable uniformity in the time of reduction of parallel tubes in this test. Johns is of the opinion that the variations encountered up to ten hours are not of sufficient magnitude to warrant placing the upper limit of accuracy below this point. The results presented in Table 1 also closely agree with the findings of previous investigators (Thornton and Hastings, 1930; Fay, 1930; Johns, 1931) that variations between replicate tests increase with increased reduction time.

TABLE 2.—*Decolorization time and standard plate count of class I samples of milk.*

Sample No.	Decolorization time.	Standard plate count.	Sample No.	Decolorization time.	Standard plate count.
	min.	*Bacteria per cc.*		*min.*	*Bacteria per cc.*
S-29	330	174,000	S-85	348	62,000
S-65	330	317,000	S-26	350	315,000
S-137	330	250,000	S-73	368	95,000
S-62	333	134,000	S-110	376	346,670
S-55	337	143,000	S-34 [a]	377	1,860,000
S-95	337	220,000	S-1	386	495,000
S-168	338	130,000	S-161	393	89,700
S-40	340	310,700	S-130	400	265,000
S-162	340	106,670	S-116	420	125,000
S-66	342	300,000	S-17	427	400,000
S-58	346	216,000			

[a] Erratic sample.

From the bottom of Table 1 it may be seen that of the 142 samples examined, 135, or 95.77 per cent, decolorized simultaneously in replicate tests and that only 6, or 4.15 per cent, decolorized at different times.

The above results clearly demonstrate the reliability of the methylene blue reduction test even when only one test is made for each sample. Although variates are likely to occur in replicate tests of the same sample, these variates are relatively so close together that they are all likely to fall within the same class.

TABLE 3.—*Decolorization time and standard plate count of class II samples of milk.*

Sample No.	Decolorization time.	Standard plate count.	Sample No.	Decolorization time.	Standard plate count.
	min.	*Bacteria per cc.*		*min.*	*Bacteria per cc.*
S-47	120	985,000	S-25	175	3,535,000
S-6 [a]	127	400,000	S-61	177	750,000
S-20	127	1,160,000	S-109	180	500,000
S-21	130	500,000	S-36 [a]	180	400,000
S-78	130	2,225,000	S-96 [a]	181	200,000
S-33	131	1,160,000	S-42	183	1,190,000
S-80	133	870,000	S-165 [a]	184	200,000
S-56	135	1,240,000	S-32	188	1,355,000
S-8	135	1,405,000	S-138	196	875,000
S-76	138	1,890,000	S-9	198	525,000
S-64	144	1,465,000	S-143	199	500,000
S-50	150	1,115,000	S-149	200	1,130,000
S-77	150	2,200,000	S-86	216	2,145,000
S-75	152	2,480,000	S-146	217	715,000
S-41	153	4,400,000	S-91	219	800,000
S-45	153	1,720,000	S-53	222	1,770,000
S-90	153	565,000	S-19	227	640,000
S-37 [a]	155	89,300	S-46 [a]	229	9,200,000
S-54	155	510,000	S-160	232	805,000
S-177 [a]	155	495,000	S-35	236	1,715,000
S-10 [a]	157	4,050,000	S-15	238	600,000
S-2	157	785,000	S-106 [a]	239	410,000
S-135	160	965,000	S-23	252	600,000
S-79	160	1,830,000	S-38	255	850,000
S-5 [a]	163	222,330	S-133	266	535,000
S-48 [a]	166	400,000	S-70 [a]	289	225,000
S-142	168	1,695,000	S-164	291	685,000
S-24	168	780,000	S-11	292	500,000
S-88	169	1,645,000	S-43	296	1,360,000
S-18	170	2,070,000	S-44	301	785,000
S-140	172	735,000	S-172	301	500,000
S-89 [a]	173	410,000	S-22	320	555,000

[a] Erratic sample.

THE SCANDINAVIAN METHOD OF INTERPRETATION

Tables 2, 3, 4, and 5 show the decolorization time and standard plate count of milks of classes I, II, III, and IV, respectively. The samples in each table are arranged in the ascending order of their approximate decolorization time. In the case of those samples that did not decolorize simultaneously in replicate tests, the mean decolorization time as shown in

TABLE 4.—*Decolorization time and standard plate count of class III samples of milk.*

Sample No.	Decolorization time.	Standard plate count.	Sample No.	Decolorization time.	Standard plate count.
	min.	*Bacteria per cc.*		*min.*	*Bacteria per cc.*
S-3 [a]	21	1,855,000	S-171 [a]	44	660,000
S-73	21	4,300,000	S-117	45	4,145,000
S-157	24	10,700,000	S-154	46	4,065,000
S-105 [a]	25	1,910,000	S-97 [a]	48	1,140,000
S-178 [a]	26	3,300,000	S-120 [a]	50	3,675,000
S-192 [a]	26	495,000	S-167 [a]	50	905,000
S-113	26	11,000,000	S-84	52	7,100,000
S-87	30	6,345,000	S-139 [a]	52	1,265,000
S-114	30	5,195,000	S-4 [a]	58	1,929,000
S-123 [a]	34	2,410,000	S-104	62	5,400,000
S-173	34	4,000,000	S-166	67	4,500,000
S-14 [a]	35	42,020	S-145 [a]	70	1,045,000
S-181 [a]	38	1,700,000	S-107	70	5,500,000
S-127	39	5,700,000	S-159	73	8,100,000
S-144	39	16,800,000	S-74 [a]	74	395,000
S-102 [a]	40	1,720,000	S-158 [a]	75	1,755,000
S-156	41	5,200,000	S-175	78	5,200,000
S-122 [a]	42	1,555,000	S-124 [a]	83	1,270,000
S-112	42	6,020,000	S-115 [a]	84	279,300
S-100 [a]	43	1,690,000	S-49 [a]	94	875,000
S-93	43	4,000,000	S-128	96	4,220,000
S-99	44	6,200,000	S-67	98	4,430,000
S-12	44	4,100,000	S-51	100	4,200,000
S-119 [a]	44	2,380,000	S-83 [a]	100	360,000

[a] Erratic sample.

TABLE 5.—*Decolorization time and standard plate count of class IV samples of milk.*

Sample No.	Decolorization time.	Standard plate count.	Sample No.	Decolorization time.	Standard plate count.
	min.	*Bacteria per cc.*		*min.*	*Bacteria per cc.*
S-31	5	20,200,000	S-136 [a]	14	14,100,000
S-25	5	50,700,000	S-148	15	22,300,000
S-60	6	86,800,000	S-72 [a]	17	5,715,000
S-71	10	25,300,000	S-7	20	34,900,000
S-39 [a]	12	8,320,000			

[a] Erratic sample.

Table 1 was taken as the decolorization time of the sample. The standard plate counts herein reported are the averages of at least two counts. The conventional method of reporting plate counts (Kolmer and Boerner, 1931, p. 409), which con-

siders only two significant left-hand digits, was disregarded and the actual count recorded so that a more accurate coefficient of correlation between the decolorization time and the standard plate count may be obtained. The results of the two tests on 142 samples of milk are also shown in text fig. 1. The standard plate counts are indicated logarithmically as ordinates of the dot diagram and the decolorization times in minutes are represented as abscissæ with natural numbers.

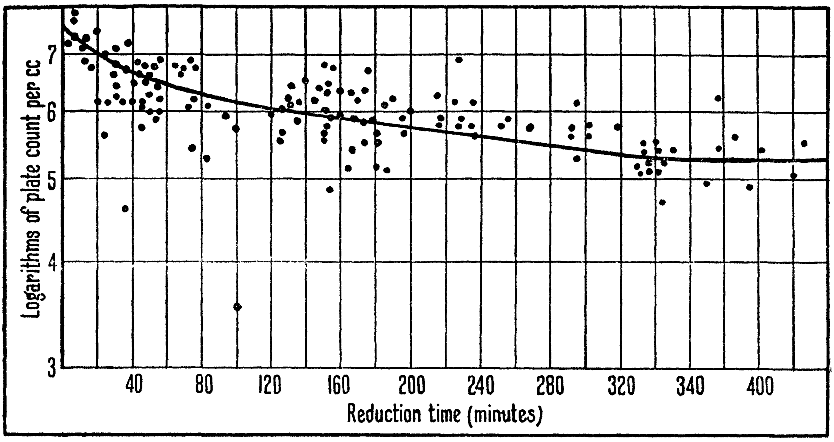

FIG. 1. Relationship between reduction time and standard plate count of each sample of milk examined.

In order to judge the efficiency of the Scandinavian method of interpretation of the reductase test, which gives the empirical equivalent in standard plate count of milk samples examined by the methylene blue reduction method and decolorizing within any of the delimiting times set for the four classes, respectively, the coefficient of correlation, together with the other statistical constants of the reduction time and standard plate count, was computed for each class and for all classes, as shown in Table 6. The table shows that a positive correlation factor was obtained for class I. This was undoubtedly due mostly to sample S–34, which decolorized in 377 minutes but gave the very high plate count of 1,860,000. Several other samples gave seemingly discrepant counts as shown in Table 2 and fig. 1. Classes, II, III, and IV show little, if any, indication of negative correlation. However, a marked negative correlation between decolorization time and standard plate count was obtained when the correlation factor was computed for all the 142 samples comprising the four different classes.

TABLE 6.—*Means, standard deviations, coefficient of variation for, and coefficient of correlation between, the plate counts and reduction times of the 142 samples of milk by the class and for all classes.*[a]

Sample classification, by the class; class (Scandinavian method).	Samples examined.	Statistical constants.			
		Mean.		Standard deviation.	
		Decolorization time.	Plate count.	Decolorization time.	Plate count.
		min.	*Bacteria per cc.*	*min.*	*Bacteria per cc.*
I	21	359.43 ± 4.48	$302{,}621 \pm 1^{4}$	29.75 ± 3.09	$365{,}753 \pm 8$
II	64	190.44 ± 4.36	$1{,}234{,}635 \pm 1^{4}$	51.41 ± 3.06	$1{,}319{,}551 \pm 7^{4}$
III	48	52.08 ± 2.21	$3{,}771{,}465 \pm 3^{5}$	22.56 ± 1.55	$3{,}189{,}172 \pm 2^{5}$
IV	9	11.55 ± 1.22	$29{,}815{,}000 \pm 5^{6}$	$5.14 \pm .81$	$23{,}963{,}967 \pm 3^{6}$
For all classes	142	157.32 ± 6.55	$3{,}765{,}753 \pm 5^{5}$	116.55 ± 4.99	$10{,}048{,}006 \pm 4^{5}$

Sample classification, by the class; class (Scandinavian method).	Samples examined.	Statistical constants.		
		Coefficient of variability.		Coefficient of correlation.
		Decolorization time.	Plate count.	
		Per cent.	*Per cent.*	
I	21	8.27 ± 0.86	120.86 ± 14.41	$+.195 \pm 0.139$
II	64	26.99 ± 1.61	106.87 ± 6.37	$-.100 \pm 0.083$
III	48	43.32 ± 2.98	87.21 ± 6.00	$-.211 \pm 0.093$
IV	9	44.54 ± 7.08	80.37 ± 12.77	$-.491 \pm 0.170$
For all classes	142	74.08 ± 3.17	266.82 ± 11.42	$-.339 \pm 0.055$

[a] A part of the computation used in this table was done by the Division of Statistics, Department of Agriculture and Commerce.

Table 7 shows the coefficient of correlation between reduction time and plate count as obtained by the present and by previous American investigations. The findings of Fay (1930) with 19 samples show that there is little if any indication of correlation. It is important to know, however, that he examined 7 samples belonging to class I, 4 to class II, 8 to class III, and none to class IV. It should also be noted that Fay used various modifications of the reduction test, and dye solution prepared both from tablet and from powder. He also examined each sample in a large series (75 to 100) and some of the samples were examined in two or three series. Fred and Chappelear (1911) examined 199 samples, using dye solution prepared from powder and obtained a coefficient of correlation of -0.6942 ± 0.03978. This decided negative correlation obtained is undoubtedly due to the fact that in its computation

TABLE 7.—*The coefficient of correlation between plate count and reduction times as obtained by different investigations.*

Number of samples examined, by the class; class.	Investigators.			
	A. C. Fay.	Fred and Chappelear.	Present investigation.	
	Samples.	Samples.	Samples.	Coefficient of correlation.
I	8	108	21	+0.1950±0.139
II	5	47	64	—0.1006±0.083
III	6	33	48	—0.2114±0.093
IV	-------------	11	9	—0.4915±0.170
Total samples examined------	19	199	142	-------------------
Coefficient of correlation for entire examination----------	—0.82±0.48	—.6942±0.03978	—0.339±0.055	-------------------

they disregarded ten samples "because of their wide variation between consecutive numbers." The results obtained by the present investigation have been discussed above. A direct comparison of the results of the three different investigations is not possible due to some difference in technic.

A cursory search of the different references on this subject revealed that no previous work has been done in correlating the reduction time to the standard plate count for each class of milk as set forth by the Scandinavian scheme of interpretation. Apparently the slight correlation obtained in the present investigation for classes II, III, and IV, as shown in Table 6, was due to the fact that milk contains a very heterogenous and variable bacterial flora. McLeod (1928) and others (Fred, 1912; Hastings, 1919; Hastings, Davenport, and Wright, 1922) believe that although all bacteria are capable of reducing methylene blue, yet they vary considerably in their activities in this respect. Thornton and Hastings (1930) think that the rate of oxygen uptake by bacteria varies sufficiently with different species and under different conditions to introduce an important factor of inaccuracy into the test. It is also possible that some organisms did not grow on agar plates but took part in the reduction of the dye. Some other inherent inaccuracies of the standard plate method as reported by Breed and Stocking (1921), Wright and Thornton (1927), and Schacht and Robertson (1931), such as clumping of bacteria and mis-

takes in counting the colonies, undoubtedly contributed to the poor negative correlation. Furthermore, the high percentage (10.07 per cent) of butter fat of carabao milk, as reported by Gomez (1926), through its creaming may remove a great number of bacteria from the body of the milk and impair the accuracy (Thornton and Hastings, 1930; Thornton, 1933) of the test. Milk, being essentially a mixed culture of various microörganisms of variable species, we have also to take into consideration the complex phenomenon (Holman, 1928) of bacterial "association" which includes "synergism," either antagonistic or beneficent, within its scope. Therefore, dye reduction in milk will be determined not only by the relative number of bacteria present in it but also by the relative number of each organism manifesting either antagonistic or beneficent synergism, since dye reduction is intimately related with the metabolic processes of bacteria. Frazier and Whittier (1931, *b*), studying the influence of the associative growth of two or more species of milk organisms on the oxidation-reduction potential of the milk, found, "that *E. coli*, *E. communior*, and *A. aerogenes*, when grown with *S. lactis*, all exerted a restraining influence on the rapid drops in Eh values usually caused by pure cultures of the latter organism and that the larger the proportion of actively growing colon-aerogenes organisms, the greater is the restraining action." Lactose, which is present in carabao milk to an average amount of 4.93 per cent (Gomez, 1926), must also receive consideration as a factor in the reduction of the dye due to its possible rôle as a hydrogen donator or metabolite in the postulated chemistry of methylene blue reduction. According to Smidt (1906), lactose in the amount of 4.6 per cent has reducing properties. It is also logical to consider fresh milk as a substance of progressively varying hydrogen-ion concentration where the "altering ionic equilibria" at different ranges of pH variously affect the oxidation-reduction system. However, as Hewitt (1933) has pointed out, the effect of the pH on the Eh is complex but not necessarily great; the difference may be within the limits of experimental error when working with biologic material.

Due to the absence of correlation between reduction time and plate count in class I and the existence of little if any indication of correlation in classes II, III, and IV, it seems apparent that the Scandinavian method offers a very inaccurate scheme of interpretation. It will be noted that the writer attempted to correlate the reduction time and the standard plate

count in his attempt to judge the efficiency of the Scandinavian method of interpretation under local conditions. While an exact relationship between the two cannot be expected, yet reduction times will be altogether meaningless unless they can be correlated with the results of well-established methods of sanitary milk control, as the standard plate method, Breed's direct microscopic method, and the like.

TABLE 8.—*The practical efficiency of the Scandinavian method of interpretation of the methylene blue reduction test.*[a]

Classification.	A. Based on reduction time.											
	Total samples.	Checked with standard plate count.										
		Correct samples.		Erratic samples.		Erratic samples with standard plate count corresponding to that of class—						
						I		II		III		IV
			P. ct.		P. ct.		P. ct.		P. ct.		P. ct.	
I	21	20	95	1	5	-----	-----	1	5	0	0	0
II	64	51	79	13	20	11	17	-----	-----	2	3	0
III	48	24	50	24	50	5	10	19	40	-----	-----	0
IV	9	6	66	3	33	0	0	0	0	3	33	-----
For all classes	142	101	71	41	28	16	11	20	14	5	3	0

Classification.	B. Based on standard plate counts.												
	Total samples.	Checked with reduction time.											
		Correct samples.		Erratic samples.		Erratic samples with reduction time corresponding to that of class—							
						I		II		III		IV	
			P. ct.		P. ct.		P. ct.		P. ct.		P. ct.		P. ct.
I	36	20	55	16	44	-----	-----	11	30	5	14	0	0
II	71	51	71	20	28	1	2	-----	-----	19	26	0	0
III	29	24	82	5	17	0	0	2	7	-----	-----	3	10
IV	6	6	100	0	0	0	0	0	0	0	0	-----	-----
For all classes	142	101	71	41	28	1	1	13	9	24	16	3	2

[a] Percentage based on the total number of samples placed in the corresponding class.

The poor correlation factor obtained for each class notwithstanding, the methylene blue reduction test cannot be condemned offhand. As has been well said by Fay, "It does not necessarily follow, however, that statistical significance and practical significance are coincident." Table 8 shows the practical evaluation of the efficiency of the Scandinavian method of inter-

pretation. The 142 samples of milk were assorted into their respective classes on two bases: (*a*) On the basis of reduction time and (*b*) on the basis of the standard plate count. The total number of samples examined in each class is given.

(*a*) *Based on reduction time.*—The samples were classified according to reduction time. Then their actual plate counts were checked with that empirically established by the Scandinavian method for the class in which they were grouped. Those that are within the plate-count limits for their respective classes are designated as "correct samples," and those that are not, "erratic samples." The right-hand column gives the class to which the erratic sample in each class should belong on the basis of plate count. Of the 21 samples classified as class I, on the reduction time basis, 20, or 95 per cent, were within the standard plate-count limits set for that class, while one (sample S–34) had a plate count that is within the higher plate-count limits set for class II milk. Similarly, class II gave 51, or 79 per cent, correct samples and 13, or 20 per cent, erratic. Classes III and IV gave only poor percentages of correct samples, 50 per cent and 66 per cent, respectively. It may, therefore, be concluded that while there is no negative correlation between reduction times and plate counts for class I and only slight negative correlation in classes II, III, and IV, it is possible, due to the presence of a marked negative correlation when that factor was based on the entire 142 samples belonging to the four different classes, that a milk sample decolorizing in a given time will, in the majority of cases, give a plate count that will fall within the wide limits set for the class to which it belongs. Table 8 shows this to be true of class I or II milk, but only slightly true in the case of class III or IV. Thus, if we were to examine 300 samples of milk and 100 of such samples decolorized in more than five and one-half hours, the 100 samples would be classified as class I milk in accordance with the Scandinavian scheme of interpretation. The bacteriologic milk standard of the local Board of Food Inspection (1932) for the Philippines has been fixed at 500,000 bacteria per cubic centimeter, which is also the maximum plate-count limit set for class I milk in the Scandinavian method. Of the 100 milk samples in the above example, we can be sure that 95 per cent, or 95 samples, have a lower plate count than 500,000, while 5 per cent, or 5 samples, may have a higher count than this. Thus, no injustice is done to the milk pro-

ducer or distributor. Obviously, the methylene blue reduction test cannot be used for drawing finer distinctions of milk quality as is done in certified milk, but such distinctions are not made in the Philippines. The low practical percentage efficiency for classes III and IV should not impair the usefulness of the Scandinavian scheme of interpretation of this test under our conditions, inasmuch as "bad" and "very bad" milk should find no place in our markets anyway. It is suggested, however, that the Scandinavian method of interpreting this test may be modified to make it better suited to Philippine conditions. The methylene blue reduction test, therefore, answers very well the need of a simple, inexpensive, and sufficiently accurate method for our local milk-control work.

(*b*) *Based on the standard plate count.*—The 142 samples were classified according to their plate counts. Thus, 36 samples were found to have a plate count of less than 500,000 per cc and were classified as class I. There were 71 samples that had a plate count of between 500,000 and 4,000,000 and were classified as class II. Classes III and IV were similarly treated. The reduction time of each sample was then checked with the reduction-time limits set for the class to which it belongs. If they check with each other, the sample is designated a correct sample, and if not, erratic sample. Obviously the erratic samples on the reduction-time basis and on the standard plate-count basis are the same and are so indicated in Tables 2, 3, 4, and 5. It will be noted that of the total of 41 erratic samples only three (S–34, S–10, and S–46) gave a higher plate count than the maximum arbitrary limit set for the class to which they belong, while the rest gave a count lower than the minimum. The absence of excessive leucocytes and long-chain streptococci, on microscopic examination of those samples, however, showed that they were not cases of abnormal milk. Evidently the latter group contained a predominant bacterial flora with pronounced reducing power. This should not upset the efficiency of the reduction test since Ellenberger and his associates (1927) have shown that the methylene blue reduction time correlates much more closely with the keeping time of milk than does the agar-plate count.

SUMMARY

1. The efficiency and interpretation of the methylene blue reduction test was studied under local conditions.

2. Results on 142 samples of milk examined confirmed previous findings that this test is characterized by a low degree of variability between replicate tubes.

3. The meager correlation obtaining between reduction time and plate count when each class is taken individually indicates, not defect in the methylene blue reduction test, but rather a necessity for modifying the Scandinavian method of grouping to suit local conditions.

4. The marked negative correlation obtaining for all the 142 milk samples taken together, without regard to classes, points, on the other hand, to the high degree of efficiency and dependability of the methylene blue reduction test. Owing to its simplicity, it would be more suitable than the standard plate method in the Philippines. It should, therefore, be seriously considered for adoption as the standard procedure in our local milk test.

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ILLUSTRATION

TEXT FIG. 1. Chart showing the relationship between reduction time and standard plate count of each sample of milk examined.

MINERAL CONSTITUENTS IN FRESH AND CANNED MILK

By A. J. Hermano and Sagrario Claravall

Of the Bureau of Science, Manila

Milk is the most satisfactory single article of food, especially for infants, because it contains proteins of good quality, oil-soluble vitamins, and also important mineral constituents, such as calcium, phosphorus, iron, copper, and manganese. Milk has only a small quantity of iron, but is high in calcium. According to Sherman(9) the iron of milk is readily absorbed and assimilated.

The dairy industry in the Philippine Islands is still undeveloped and at present pasteurized milk is rather expensive. Both the wealthy and poor people generally use canned milk for feeding infants.

Daniels and Laughlin(4) reported that the process of pasteurization renders the calcium salts in milk somewhat insoluble. In the pasteurization apparatus a deposit (milk stone) is usually formed. During the process of preparing sterilized natural milk and evaporated and sweetened condensed milk slow heating may remove very appreciable amounts of calcium. The storing and aging of milk in a hot tropical country also affects the composition of the milk.

Some analyses of canned milk sold in the Philippines and also native milk, both human and carabao, have been made.(2) The results give data on the common milk constituents, such as fat and ash, but do not give any definite information concerning the amounts of calcium, iron, and phosphorus contained in the milk.

In this investigation a number of samples of milk were analyzed particularly for the calcium, iron, and phosphorus contents in addition to the common milk constituents. We purchased the most popular brands of milk sold in the grocery stores in Manila. Various kinds of milk, such as natural sterilized, evaporated, sweetened condensed, and powdered milk, were investigated. In addition to canned milk we also analyzed reconstituted cow's milk and fresh milk from carabaos, goats,

and cows kept at the Alabang experiment station of the Bureau of Animal Industry. Altogether forty-five samples of milk were analyzed.

The analyses of the milk for fat, protein, and the other common constituents were made according to the methods of the Association of Official Agricultural Chemists.(8) The results are recorded in Table 1. The calcium, phosphorus, and

TABLE 1.—*Analyses of various kinds of milk.*

Kind of milk.	Water.	Fat.	Ash.	Protein (Nx6.38).	Lactose (by difference).	Sucrose.
Natural sterilized milk:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Bear	87.05	3.52	0.72	3.32	5.39	----------
Brunn	87.28	3.52	0.76	3.31	5.13	----------
Hollandia	88.20	3.52	0.75	3.16	4.37	----------
Milkmaid	87.95	3.52	0.73	3.24	4.56	----------
Phoenix	88.00	3.87	0.66	3.39	4.08	----------
Evaporated milk:						
All Pure	70.83	7.90	1.45	8.53	11.29	----------
All Pure (goat's milk)	73.00	9.89	1.34	5.99	9.78	----------
Alpine	70.90	7.92	1.63	9.21	10.34	----------
Armour	69.10	8.10	1.33	9.08	12.39	----------
Carnation	70.11	7.88	1.51	7.72	12.78	----------
Darigold	74.08	7.47	1.08	6.59	9.78	----------
Libby	68.05	7.92	1.54	8.70	13.79	----------
Meiji	72.58	7.95	1.65	7.95	9.87	----------
Milkmaid	69.37	8.10	1.64	8.68	12.25	----------
Pet	69.91	7.87	1.87	6.70	13.65	----------
Powdered milk:						
Dryco	3.14	12.50	7.43	32.09	44.84	----------
Horlick	3.28	15.72	3.84	14.01	63.15	----------
Klim	1.58	28.22	5.48	24.56	40.16	----------
Lactogen	1.68	24.44	5.13	24.77	43.98	----------
Molico	1.40	28.04	5.80	26.87	37.89	----------
Nestogen	2.78	21.62	4.95	20.59	50.06	----------
Fresh goat's milk from Alabang:						
Anglo Nubian No. 1342	86.44	3.07	0.81	3.07	6.61	----------
Grade Nubian No. 1227	88.70	3.84	0.66	3.04	3.76	----------
Grade Nubian No. 1312	87.40	3.87	0.64	3.36	4.73	----------
Grade Nubian No. 1350	86.27	4.67	0.76	3.34	4.96	----------
Toggenberg breed No. 1025	87.92	3.24	0.83	3.19	4.82	----------
Toggenberg breed No. 1027	87.64	3.89	0.78	3.36	4.33	----------
Miscellaneous samples (fresh milk):						
Red Scindi cow No. 5 second lactation	89.15	3.32	0.82	3.00	3.71	----------
Red Scindi cow, 6 years, third lactation	87.20	3.28	0.84	3.30	5.38	----------
Cow No. 1281. Half-breed Ayrshire and Nelson	87.07	4.80	0.85	3.57	3.72	----------

TABLE 1.—*Analyses of various kinds of milk*—Continued.

Kind of milk.	Water.	Fat.	Ash.	Protein (Nx6.38).	Lactose (by difference).	Sucrose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Miscellaneous samples (fresh milk)—Continued.						
Cow No. 2291. One-fourth Ayrshire and Nelson, second lactation	86.98	3.89	0.82	3.13	5.18	----------
Carabao milk (local dairy)	79.63	10.05	0.64	5.38	4.30	----------
Magnolia reconstituted milk. Prepared from butter and powdered skimmed milk	87.13	3.61	0.78	3.14	5.34	----------
Sweetened condensed milk:						
Brunn	20.08	10.08	2.06	7.04	14.17	46.57
Carnation	20.50	8.02	1.92	8.62	12.55	48.39
Garsco	22.39	8.64	1.69	8.12	13.70	45.46
Hollandia	22.88	8.02	1.50	8.42	14.43	44.75
Libby	23.23	8.92	1.79	7.04	14.68	44.36
Lifeguard	23.58	8.64	1.55	8.05	12.24	45.94
Merry	20.31	9.36	1.92	8.07	11.95	48.39
Milkmaid	20.12	9.36	1.93	8.75	13.59	46.25
Morinaga	20.86	10.08	1.91	8.02	14.77	44.36
My Boy	24.17	8.02	1.69	8.12	11.43	46.57
Swan Danish	20.85	8.64	1.88	9.22	15.13	44.28
Train	24.26	9.36	1.72	7.79	13.46	43.41

iron contents of the milks are given in Table 2. The calcium and phosphorus were determined by the official methods applicable to plant materials other than seeds.(8) Analysis for iron was made according to Stugart's method.(10)

RESULTS

The results for evaporated whole milk, powdered whole milk, and sweetened condensed milk agree, in general, with the data given by the associates of Rogers(3) for these products.

Fresh cow's milk gave a higher percentage of ash (Table 1) and calcium (Table 2) than the natural sterilized milk.

Milk from carabaos had the lowest ash content (0.64 per cent) but the ash had the highest amount of calcium (27.99 per cent). Carabao milk also had more fat and protein than the other natural fresh milks (Table 1).

The Toggenberg breed of goats gave milk with a higher lime content than any other breed of goats.

Klim and Molico (whole powdered milks) gave the highest percentage of fat.

TABLE 2.—*Mineral contents of various kinds of milk.*

Kind of milk.	CaO			P_2O_5			Fe_2O_3		
	On wet basis.	On dry basis.	In ash.	On wet basis.	On dry basis.	In ash.	On wet basis.	On dry basis.	In ash.
Natural sterilized milk:									
Bear	0.17	1.36	24.52	0.24	1.85	33.34	0.00035	0.00271	0.0500
Brunn	0.18	1.46	24.44	0.20	1.60	26.79	0.00031	0.00243	0.0443
Hollandia	0.18	1.51	23.82	0.21	1.78	28.06	0.00035	0.00300	0.0486
Milkmaid	0.17	1.44	23.90	0.23	1.91	31.65	0.00034	0.00271	0.0473
Phoenix	0.15	1.31	23.89	0.23	1.92	34.98	0.00032	0.00273	0.0507
Evaporated milk:									
All Pure	0.32	1.12	22.58	0.44	1.50	30.29	0.00084	0.00282	0.0587
All Pure (goat's milk)	0.32	1.19	23.97	0.47	1.76	35.64	0.00067	0.00248	0.0407
Alpine	0.39	1.35	24.15	0.53	1.83	29.94	0.00070	0.00240	0.0428
Armour	0.35	1.12	26.18	0.46	1.49	34.65	0.00070	0.00230	0.0533
Carnation	0.38	1.26	25.06	0.45	1.52	30.19	0.00075	0.00253	0.0507
Darigold	0.26	0.99	25.31	0.38	1.45	35.03	0.00068	0.00264	0.0643
Libby	0.27	1.17	24.38	0.45	1.43	29.69	0.00074	0.00233	0.0486
Meiji	0.37	1.34	22.38	0.49	1.79	29.80	0.00074	0.00270	0.0457
Milkmaid	0.40	1.31	25.03	0.45	1.48	28.43	0.00073	0.00237	0.0457
Pet	0.46	1.54	24.88	0.56	1.86	29.97	0.00080	0.00265	0.0428
Powdered milk:									
Dryco	1.79	1.85	24.18	2.21	2.28	29.76	0.00373	0.00384	0.0503
Horlick	1.96	1.00	25.21	1.14	1.18	29.80	0.00385	0.00418	0.1005
Klim	1.28	1.30	23.44	1.75	1.78	32.04	0.00600	0.00609	0.1095
Lactogen	1.27	1.29	24.75	1.64	1.65	32.04	0.00553	0.00561	0.1079
Molico	1.46	1.48	25.17	1.72	1.77	29.75	0.00619	0.00633	0.1068
Nestogen	1.24	1.27	25.03	1.53	1.58	31.02	0.00339	0.00348	0.0686

Fresh goat's milk from Alabang:									
Anglo Nubian No. 1342	0.19	1.45	24.40	0.24	1.79	30.01	0.00037	0.00271	0.0461
Grade Nubian No. 1227	0.15	1.37	23.55	0.21	1.87	32.02	0.00035	0.00314	0.0544
Grade Nubian No. 1312	0.16	1.27	25.00	0.20	1.57	31.01	0.00030	0.00208	0.0473
Grade Nubian No. 1350	0.19	1.37	24.72	0.23	1.66	29.75	0.00031	0.00228	0.0427
Toggenberg breed No. 1025	0.20	1.74	24.24	0.24	2.04	29.73	0.00038	0.00320	0.0476
Toggenberg breed No. 1027	0.19	1.54	24.49	0.23	1.86	29.52	0.00032	0.00257	0.0421
Miscellaneous samples (fresh milk):									
Red Scindi cow No. 5	0.19	1.78	23.68	0.24	2.24	29.72	0.00037	0.00341	0.0470
Red Scindi cow, 6 years, third lactation	0.20	1.56	23.77	0.26	1.94	29.59	0.00031	0.00244	0.0390
Cow No. 1281, half breed Ayrshire and Nelson	0.20	1.59	24.24	0.25	1.94	29.56	0.00030	0.00231	0.0368
Cow No. 2291, 5 years, three-fourths Ayrshire one fourth Nelson, second lactation	0.20	1.52	24.19	0.24	1.87	29.69	0.00038	0.00295	0.0487
Carabao milk	0.18	0.88	27.99	0.21	1.04	32.27	0.00031	0.00300	0.0490
Magnolia reconstituted milk	0.19	1.47	24.19	0.25	1.93	31.87	0.00034	0.00328	0.0438
Sweetened condensed milk:									
Brunn	0.49	0.62	24.02	0.64	0.80	31.13	0.00110	0.00137	0.0534
Carnation	0.48	0.60	25.04	0.60	0.75	31.28	0.00107	0.00135	0.0564
Garsco	0.41	0.53	24.49	0.54	0.72	33.05	0.00127	0.00162	0.0753
Hollandia	0.35	0.45	23.45	0.47	0.66	31.28	0.00095	0.00124	0.0644
Libby	0.41	0.54	23.60	0.54	0.71	30.79	0.00107	0.00140	0.0613
Lifeguard	0.39	0.51	25.07	0.48	0.63	31.27	0.00088	0.00115	0.0773
Merry	0.45	0.57	23.82	0.61	0.77	32.06	0.00104	0.00130	0.0544
Milkmaid	0.45	0.57	23.70	0.57	0.71	29.64	0.00095	0.00120	0.0504
Morinaga	0.45	0.57	23.78	0.56	0.71	29.63	0.00100	0.00127	0.0529
My Boy	0.40	0.53	24.07	0.53	0.70	31.43	0.00095	0.00125	0.0571
Swan Danish	0.44	0.56	23.77	0.57	0.72	30.34	0.00098	0.00124	0.0524
Train	0.45	0.57	23.78	0.56	0.71	29.63	0.00100	0.00127	0.0529

SUMMARY

In this investigation forty-five samples of milk were analyzed particularly for the calcium, iron, and phosphorus contents. The common milk constituents, such as fat and ash, were also determined.

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THE BREEDING HABITS OF ANOPHELES LITORALIS AND A. INDEFINITUS IN SALT-WATER PONDS [1]

By W. V. KING

Of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington

and

F. DEL ROSARIO

Of the National Museum Division, Bureau of Science, Manila

SEVEN PLATES AND TWO TEXT FIGURES

Miscellaneous collections of *Anopheles* larvæ in salt-water and brackish-water ponds near Manila had been made during the dry season in 1929 and again in 1931, and brief notes on the occurrence of *A. litoralis* King and *A. indefinitus* Ludlow (*A. subpictus* var. *indefinitus*) in these ponds were given in a previous article.[2] The observations had indicated that the optimum salt concentration was somewhat different for each of the two species. During the year beginning July, 1931, periodic collections were made in the same ponds in order to obtain information on the relative species variation in the rainy and dry seasons, and the records are summarized in the present paper.

Near the municipality of Las Piñas, about 14 kilometers south of the Government center in Manila, is an area where salt is manufactured by the evaporation of sea water. The salt beds (Plate 2), which are paved or tiled and from which the salt is collected after evaporation has taken place, are connected with a series of concentration ponds where the preliminary evaporation occurs. The pond farthest from the salt beds is connected by a ditch with one of the numerous esteros, or tidal canals. During the period of salt manufacture the inflow of water at one end and the collection of salt at the other

[1] The studies on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation, in coöperation with the Bureau of Science of the Philippine Government.

[2] King, W. V., Philip. Journ. Sci. 47 (1932) 305–342, illus.

are more or less continuous, so that the salt concentration in the different ponds is progressively higher. The plot selected for observation consisted of a series of five ponds separated from one another by low dikes (Plate 1 and text fig. 1), the upper one of which was designated C–4, the next C–3, etc., the salt bed being C–0. Regular collections were made only in C–3

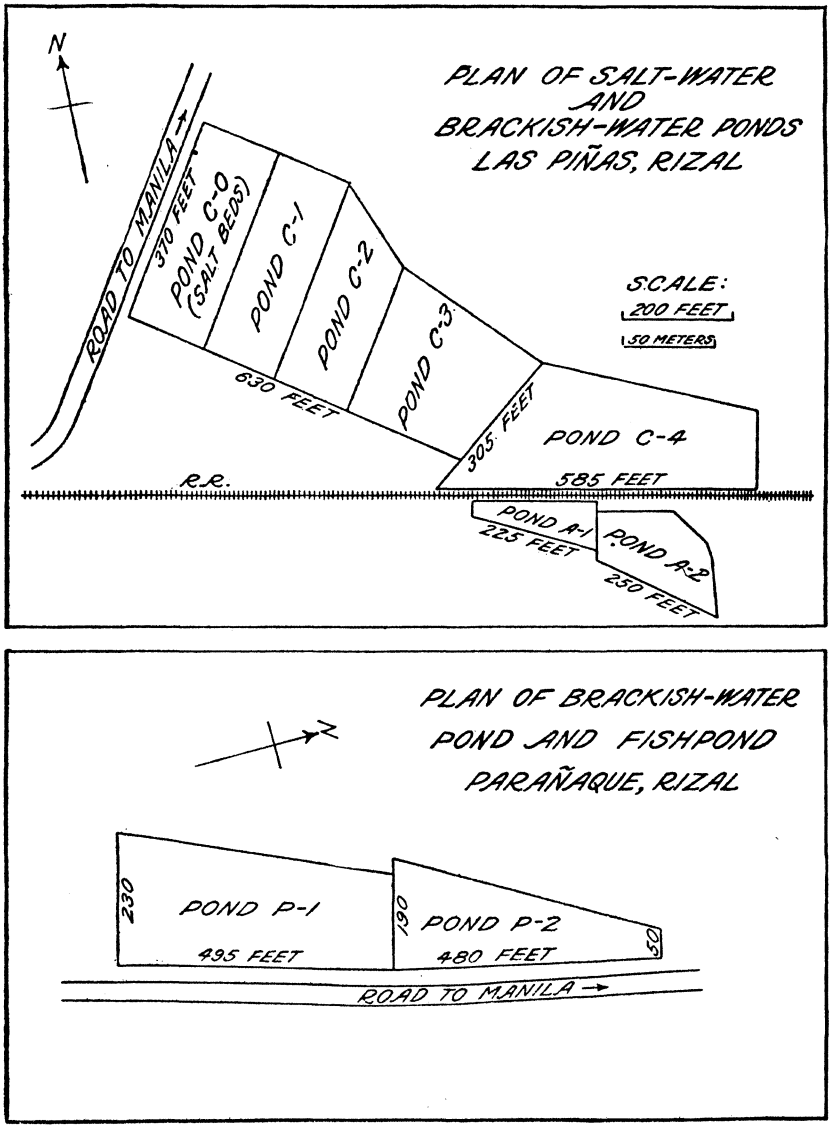

FIG. 1. A sketch of the ponds where *Anopheles*-breeding studies were made, showing their approximate size and location.

and C–4, but occasional collections were also made in the other ponds.

Across a railroad embankment from the upper end of the concentration ponds were two smaller, unused pools, which had no direct connection with sea water and usually contained only brackish water. These are referred to as ponds A–1 and A–2 (Plates 4 and 5). The second of these (A–2) was separated from an adjoining fishpond only by a small dike, and it probably received an overflow of salt water occasionally, as its salt content was higher than that of A–1 most of the time.

Two other ponds near the municipality of Parañaque and 4 or 5 kilometers nearer Manila were also selected for the collections. One of these (pond P–2, Plate 6) is a fishpond that is supplied with sea water as required to maintain the proper level; the other (P–1, Plate 7) is an abandoned fishpond and, although separated from P–2 merely by a dike, contained only slightly brackish water except when its volume had been greatly reduced by evaporation.

The six ponds (text fig. 1) in which regular collections were made consisted, therefore, of three "salt-water ponds" (C–4, C–3, and P–2) and three "brackish-water ponds" (A–1, A–2, and P–1). The descriptive terms are only approximate, however, since the water in all the ponds becomes much diluted during the rainy season and highly concentrated during the dry season. The dividing line between "brackish" and "salt" is not definite either, but for our purposes brackish water is considered as containing up to 2 per cent of salt and salt water above 3 per cent, between 2 and 3 per cent being intermediate.

METHODS OF DETERMINING THE SALT CONTENT

For the purpose of this study it was considered unnecessary to determine the salt content with great accuracy (as by titration for chlorine or other chemical method), and the salt percentages were calculated simply from hydrometer readings. These were made with two instruments on nearly all samples, one being used as a check against the other. One was a small specific-gravity spindle graduated from 1.000 to 1.060 and calibrated at 15° C. (59° F.), and the other was a salt hydrometer graduated from 0 to 100 per cent of saturation and calibrated at 60° F. Since the temperature of the pond water varied from about 26° to 31° C. (78.8° to 87.7° F.), the readings were corrected approximately to these temperatures. For

the specific-gravity readings a table and graph giving the percentages of salt with water temperatures of 27° and 30° C. (80.6° and 86° F.) were drawn up from Olsen's salt table by multiplying the specific-gravity readings by factors of 1.00259 and 1.00346, respectively, and correcting to the nearest of these two temperatures. For the salt hydrometer a graph was drawn for the corrected readings at 29° C. (84.2° F.).[3] The salt hydrometer was expected to be less accurate than the specific-gravity spindle, since it covered a wider range of salt concentration, but the readings proved to be fairly close, with variations of only 0.1 to 0.3 per cent in the majority of cases. It might be mentioned, however, that on comparing three specific-gravity spindles, all calibrated at the same temperature, considerable variation was shown, averaging about four points (0.004) and corresponding to about 0.55 per cent of salt difference between the highest and the lowest. One of these was a urinometer and the other a standard-size specific-gravity hydrometer. The intermediate one of the three gave the nearest to correct readings when tested with known solutions and is the one from which the percentages used in the present paper were taken.

Check readings with this spindle on known solutions, in which the sodium chloride had been thoroughly dried before weighing, were as follows:

Salt (NaCl) in 100 cc of solution g	1.00	2.00	3.00
Specific gravity readings at 30.5° C. (86.9° F.)	1.0045	1.0115	1.0180
Calculated percentage of salt	1.09	2.07	2.97

IDENTIFICATION OF MATERIAL

Most of the identifications were made of fourth-instar larvæ, and the characters that were mainly depended upon for the separation of the two species considered in this paper were as follows:

Anopheles litoralis.—First palmate hair undeveloped, hairlike, or, if leaflets slightly broadened, without a differentiated filament; pecten with all the teeth of nearly equal length.

Anopheles indefinitus.—First palmate hair, although smaller than the succeeding ones, with developed leaflets and apical filaments; pecten with some of the teeth about twice the length of the others.

[3] The table and graphs were prepared by Mr. José C. Espinosa, of the Bureau of Science, to whom the authors wish to express their indebtedness.

These characteristics are not very pronounced and, at the beginning of the study, a considerable number of the larvæ were reared through to the adult stage in order to have a check on the specificity of the characters and on the accuracy of identification. The total numbers of specimens identified in both the larval and adult stages, those collected as pupæ and identified in the adult stage only, and those determined only as larvæ are shown in Table 1. The data also indicate that the emergence of females of these two species is only slightly in excess of that of males.

TABLE 1.—*Total numbers of specimens of Anopheles litoralis and A. indefinitus collected in the ponds under observation.*

Identifications.	*A. litoralis.*			*A. indefinitus.*		
	Total.	Males.	Females.	Total.	Males.	Females.
Both as larvæ and adults	587	287	300	1,672	778	894
As adults only	550	263	287	535	246	289
As larvæ only	3,895			753		
Total	5,032	550	587	2,960	1,024	1,183

Although culicine larvæ were frequently abundant in the ponds, the only other anophelines encountered in these breeding places during the study were four specimens of *Anopheles philippinensis* Ludlow collected by F. E. Baisas from pond P-1, February 5, at a time when the pond was filled with fresh water.

RAINFALL

The normal annual rainfall for Manila, according to the records of the Manila Central Observatory, is 2,046.8 mm (80.6 inches), more than two-thirds of which (1,455 mm) occurs during the four months from June to September. The five months from December to April comprise a distinctly dry season, with an average monthly rainfall of only 29 mm (1.14 inches).

As shown in Table 2, the greatest departures from normal occurred during July and August, at the beginning of the period covered by the study. Less than half of the normal rainfall occurred in July; so the water level of the ponds was not much raised during this month. The total of 1,466 mm (57.7 inches) in August, however, was more than three times the normal, and exceedingly heavy downpours on the 11th, 12th, and 13th,

when a total of 721 mm (28 inches) was recorded, completely flooded all the collecting areas and eliminated practically all mosquito breeding for the time being. Although the excessive amount of water at this time was far from normal, the extreme variation undoubtedly provided more interesting data than might otherwise have been obtained. In contrast, the four months from January to April were almost rainless and made possible observations at the opposite extreme.

TABLE 2.—*Monthly rainfall July, 1931, to June, 1932, inclusive, and normal rainfall for Manila.*

Month.	1931–1932		Normal.	
	mm.	*in.*	*mm.*	*in.*
July	180.4	7.10	418.4	16.47
August	1,465.9	57.71	426.5	16.79
September	329.6	12.98	355.3	13.99
October	170.9	6.73	187.9	7.40
November	249.1	9.81	138.1	5.44
December	95.9	3.77	60.9	2.40
January	0.3	0.01	24.4	0.96
February	0.0	0.00	11.2	0.44
March	7.9	0.31	17.7	0.70
April	0.0	0.00	31.4	1.24
May	164.7	6.48	120.0	4.72
June	315.8	12.43	255.0	10.04
Total	2,980.5	117.33	2,046.8	80.59

BREEDING CONDITIONS AND ALGAL GROWTHS IN THE PONDS

Breeding of *Anopheles* larvæ in these ponds is practically always associated with growths of aquatic vegetation, usually algæ. Therefore, notes were kept on the principal species and the amounts present in the ponds at various times. The commonest forms encountered during the survey were as follows:[4]

Chaetomorpha sp., a coarse filamentous green alga, which forms large floating mats in the fishponds and the salt-concentration ponds, is normally found in water of a fairly high salt content and usually indicates the presence of *A. litoralis* larvæ. In the ponds where it was well established prior to the rainy season, it was found to develop after the salt water had been much diluted, and under these conditions contained *A. indefinitus* larvæ. However, it was seldom found in the

[4] The authors are indebted to Dr. E. Quisumbing, of the Bureau of Science, and to Prof. N. L. Gardner, of the University of California, for identifications of the algæ.

brackish-water ponds even after the salt content had increased as a result of evaporation. In the other ponds this alga, with *Lyngbya majuscula,* was the predominant growth during the dry season (Plates 3 and 6).

Lyngbya majuscula, a filamentous blue-green alga with a much finer strand than *Chaetomorpha,* is more frequently found in salt-water than in brackish-water ponds, and its mats may or may not be mixed with those of *Chaetomorpha.* The dark brown or bluish appearance of the mats distinguishes them from the light yellowish green of *Chaetomorpha* mats. Large mats of a nearly pure growth of this species occurred in pond A–2 (Plate 5) from February to July, at salt percentages ranging from 1.6 to 9.2. In the fishpond (P–2) the species was abundant from April to July.

Lyngbya aestuarii, similar in general to the preceding species, but probably preferring water of a lower or intermediate salt concentration, was recorded most frequently in ponds C–3 and C–4 from September to February, at salt concentrations of from 1 to 4 per cent and appeared in large mats at concentrations of from 1.0 to 1.6 per cent. It disappeared (or was observed only in a decayed condition) after February 19 and was not observed during the remainder of the dry season.

None of these three species occurred to any extent in the two more strictly brackish-water ponds, A–1 and P–1, and, in fact, were recorded in these only three or four times, in small quantities.

Enteromorpha tubulosa, a large, tubular alga of irregular occurrence, both as to type of pond and amount of salt, was recorded as abundant in water ranging from 0 to more than 4 per cent salt, and as moderately abundant in water of salt content up to 6 per cent. It was noted most frequently in ponds A–1 and P–2, and in the ditch along the side of C–1 and C–2. The large size of the filament and the loosely formed growths, which are never extensive, make it a much less favorable source of larval food or protection than the other forms. In certain collections, however, it was the only or principal species recorded at times when larvæ were numerous, these consisting sometimes of *A. litoralis* and sometimes of *indefinitus.*

Hydrocharitaceæ. A plant, similar in general appearance to *Chara* but thought by Doctor Quisumbing to belong to the frogbit family, grew luxuriantly in the three brackish-water ponds and produced favorable mosquito-breeding conditions, usually containing *A. indefinitus* but occasionally *litoralis* also.

Pond A–1 and the much larger pond P–1 were almost completely filled with this *Chara*-like plant during a large part of the year. It disappeared during the dry season but quickly became reëstablished with the beginning of the rains, showing up in the bottom of A–1 while the salt content was still 2.5 per cent. In pond A–2 it was noted as fairly abundant from January 8 to March 4. It was also found in the concentration ponds C–4 and C–2 from October to November (during the rainy season), where it developed while the water contained less than 1.25 per cent of salt. It was recorded as abundant in C–4 October 14 and in C–3 each of the three collecting dates from October 14 to November 3. In the fishpond (P–2) it was noted in small amounts from November 3 to January 22, when the salt content ranged from 1.0 to 2.7 per cent, which appeared to be nearly the limit of tolerance.

Certain other algæ, such as *Spirogyra*, *Xenococcus*, *Lyngbya confervoides*, and *Pithophora* sp., were identified by Professor Gardner from our material, but they were seldom abundant enough to be much of a factor in mosquito breeding. Of the higher plants, duckweed (*Lemna* sp.) and a species of salt grass (*Paspalum vaginatum*) were noted on occasion, and during January the duckweed formed a heavy growth on the surface of pond A–1.

As a result of the excessive flooding in August, practically all the floating algæ disappeared, having either been sunk or washed away, and the *Chara*-like plant, which was rooted in the bottom mud, was covered so deeply with water that the tops failed to reach the surface. August 17 only two larvæ could be found in the ponds after several hours' search. By September 3 the water level had lowered and the tops of the *Chara*-like plant reached the surface in ponds A–1 and P–1, where *Anopheles* breeding had been resumed. A small amount of *Lyngbya aestuarii* was noted in ponds C–3 and C–4 on this date, and larvæ were found in this alga September 14.

Even after the return of more normal water conditions the plant growths were subject to considerable, sometimes sudden, variations both as to species and abundance, due to changes in the salt content of the water, to hand removal in some cases, and to other, undetermined, causes. Certain of the abrupt changes in larval abundance in individual ponds and on consecutive collection dates were attributable to such fluctuations in the algal growths.

As elsewhere, the algal and other plant growths undoubtedly serve both as larval food and as protection against fish and other predators. Only once were larvæ found unassociated with such growths, and this was May 20 in small pools recently formed in pond P–1, which had previously been completely dry. In the absence of both fish and algæ, larvæ of *A. litoralis* were found floating free on the surface, much like those of *A. vagus* in similar open pools of fresh water.

VARIATIONS IN SALT PERCENTAGES

The maximum and minimum salt percentages on each collecting date are given in Table 3 and text fig. 2. The percentages for each of the ponds are included in Table 4.

The first collection of the series was made after the rainy season had begun, with the ponds already beginning to show dilution. Immediately after the heavy August rains hardly a trace of salt could be noted in most of the breeding places, and the maximum reading August 17 was 0.7 per cent. By the next collecting date (September 3) ponds P–2 and C–4 had recovered somewhat, but during the remainder of 1931 the rainfall was sufficient to maintain all the ponds in a diluted condition, with a maximum showing of 1.7 per cent salt. The first pond to go above 2 per cent, probably as a result of the letting in of sea water, was the fishpond P–2, in which a reading of 2.3 per cent was obtained January 8. The same date pond A–1 began to show an appreciable amount of salt again,[5] after a lapse of two months, probably indicating that evaporation had begun to exceed the precipitation. February 5 the salt pond C–4 showed 3.5 per cent salt, and February 19 the brackish pond P–1 showed the presence of salt for the first time since July.

In March the concentration ponds and salt beds were cleaned preparatory to salt manufacture, and until June 22 the salt content in these remained above 4 per cent, mostly from 5 to 7 per cent. The brackish pond A–2 rose to 1.3 per cent salt February 5 and to 3.0 per cent March 4, taking the status of a salt pond for the remainder of the dry season. Pond A–1 reached 2.3 per cent salt April 15 and 4.2 per cent the 29th. Pond P–1 gave a reading of 1.4 per cent April 1 and 2.5 per cent April 15, but was entirely dry the 29th. After light rains

[5] See footnote *a*, Table 3.

TABLE 3.—*Collections of Anopheles larvæ and salt content of water in the breeding places.*

Date.	Collections from selected stations.						Additional collections.				Totals.	
	Collections.	*A. litoralis.*	*A. indefinitus.*	Per collection.		Salt content.[a]	Collections.	*A. litoralis.*	*A. indefinitus.*	Salt content.[a]	*A. litoralis.*	*A. indefinitus.*
				A. litoralis.	*A. indefinitus.*							
1931						*Per cent.*				*Per cent.*		
July 27	4	198	15	49.5	3.7	1.6–3.1	1	3	0	3.1	201	15
August 17	4	1	1	0.2	0.2	0.0–0.7					1	1
September 3	4	60	68	15.0	17.0	0.0–1.1					60	68
September 14	5	60	127	12.0	25.4	0.0–1.3					60	127
September 24	6	72	218	12.0	36.3	0.0–1.3	1	4	3	1.1	76	221
October 4	6	44	478	7.3	79.7	0.0–1.0					44	478
October 14	6	47	294	7.8	49.0	0.0–1.1					47	294
October 24	6	29	239	4.8	39.8	0.0–1.0					29	239
November 3	6	17	128	2.8	21.3	0.0–1.1					17	128
November 18	6	2	106	0.3	17.7	0.0–1.3					2	106
December 16	5	14	196	2.8	39.2	0.0–1.7					14	196

1932												
January 8	5	7	119	1.4	23.8	0.0–2.3	....	....	....	....	7	119
January 22	5	7	154	1.4	30.8	0.0–2.8	....	....	....	....	7	154
February 5	5	110	178	22.0	35.6	0.0–3.5	....	....	....	....	110	178
February 19	5	170	183	34.0	36.6	0.3–4.2	....	....	....	....	170	183
March 4	6	151	97	25.2	16.2	0.6–6.0	3	51	0	2.7–6.7	202	97
March 18	6	330	113	55.0	18.8	0.9–5.5	3	142	0	2.8–7.3	472	113
April 1	6	586	219	97.7	36.5	1.4–6.7	4	353	0	4.2–8.8	939	219
April 15	6	331	2	55.2	0.3	2.3–6.7	4	135	0	3.7–8.8	466	2
April 29	5	198	0	39.6	0.0	4.2–6.6	4	386	0	4.6–6.0	584	0
May 20	6	340	0	56.7	0.0	3.5–9.2	3	184	0	4.6–4.8	524	0
June 22	6	331	0	55.2	0.0	1.6–4.2	2	80	0	3.0	411	0
July 15	6	565	22	94.2	3.7	1.3–3.2	2	24	0	2.8	589	22
Total or average	125	3,670	2,957	29.4	23.7	....	27	1,362	3	....	5,032	2,960

[a] Specific gravity of 1,000 or less and hydrometer readings of 0 were usually recorded as 0 per cent salt without adjustment for temperature. A certain amount of salt was undoubtedly present in solution at all times.

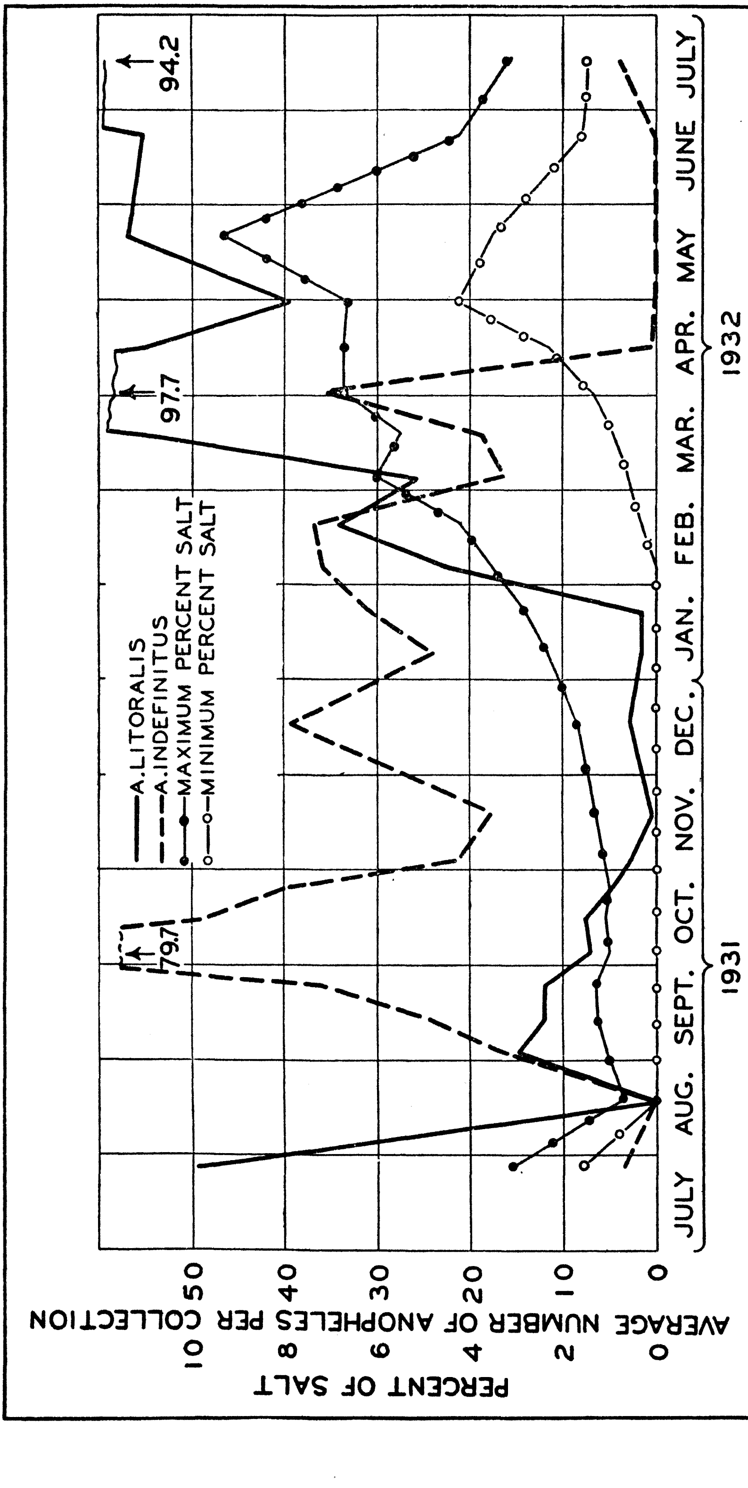

FIG. 2. The salt content and the seasonal abundance of larvæ of *A. litoralis* and *A. indefinitus* in six ponds under observation from July, 1931, to July, 1932. The circles on the lines representing maximum and minimum percentages of salt do not coincide with the dates of observation, which were the same as those for the larval collections.

in May several pools were formed and the water, after standing on the salt-impregnated soil, showed from 3.5 to 4.6 per cent salt (P–1 and P–1a).

The period covered by the study extended into the beginning of the second rainy season and, rather curiously, in the five ponds from which collections were made both the first and last dates of the series, the salt percentages had returned July 15, 1932, nearly to the points at which they had begun July 27, 1931.

TABLE 4.—*Salt content and collections of Anopheles larvæ in individual ponds.*

Date.	Pond A–1.			Pond A–2.			Pond P–1.		
	Salt content.	Larvæ.		Salt content.	Larvæ.		Salt content.	Larvæ.	
		A. litoralis.	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*
1931	*Per cent.*			*Per cent.*			*Per cent.*		
July 27	--------	--------	--------	2.4	43	0	1.6	83	15
Aug. 17	0.7	0	0	([a])	--------	--------	0.0	1	1
Sept. 8	0.8	26	42	([a])	--------	--------	0.0	34	26
Sept. 14	0.9	3	46	1.2	0	0	0.0	7	51
Sept. 24	0.6	0	59	0.9	3	0	0.0	0	94
Oct. 4	0.7	1	175	1.0	0	24	0.0	0	64
Oct. 14	0.7	0	117	1.0	2	14	0.0	0	91
Oct. 24	0.6	0	41	0.9	0	12	0.0	0	78
Nov. 3	0.6	0	17	1.0	4	5	0.0	0	17
Nov. 18	0.0	0	19	0.6	0	6	0.0	0	17
Dec. 16	0.0	0	56	0.7	1	19	0.0	0	64
1932									
Jan. 8	0.5	0	10	0.8	0	12	0.0	0	39
Jan. 22	0.6	0	18	0.9	0	12	0.0	0	41
Feb. 5	0.4	0	14	1.3	0	74	0.0	0	[b] 88
Feb. 19	0.6	0	24	1.6	20	41	0.3	0	116
Mar. 4	0.7	0	67	3.0	86	9	0.6	0	21
Mar. 18	0.9	117	43	4.2	107	0	0.9	0	70
Apr. 1	1.4	91	109	6.7	166	0	1.4	0	110
Apr. 15	2.3	162	1	6.7	47	0	2.5	0	1
Apr. 29	4.2	128	0	6.6	0	0	([c])	([c])	([c])
May 20	5.4	136	0	9.2	0	0	3.5	104	0
June 22	2.6	84	0	4.2	76	0	1.6	44	0
July 15	1.5	124	15	3.2	148	0	1.3	16	7
Total--	--------	872	873	--------	703	228	--------	289	1,011

[a] Ponds A-1 and A-2 continuous. [b] Also four A. *philippinensis* larvæ. [c] Dry, no collection.

TABLE 4.—*Salt content and collections of Anopheles larvæ in individual ponds*—Continued.

Date.	Pond P-2.			Pond C-4.			Pond C-3.		
	Salt content.	Larvæ.		Salt content.	Larvæ.		Salt content.	Larvæ.	
		A. litoralis.	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*
1931	*Per cent.*			*Per cent.*			*Per cent.*		
July 27	3.0	46	0	3.1	26	0	--------	(d)	(d)
Aug. 17	0.7	0	0	0.0	0	0	(e)	--------	--------
Sept. 3	1.1	0	0	1.1	0	0	(e)	--------	--------
Sept. 14	1.3	0	0	1.3	50	30	(e)	--------	--------
Sept. 24	1.1	0	0	1.3	38	43	1.1	31	22
Oct. 4	0.7	5	3	1.0	30	195	1.0	8	17
Oct. 14	1.0	3	1	1.1	8	39	1.1	34	32
Oct. 24	0.9	0	15	0.9	1	64	1.1	28	29
Nov. 3	1.0	0	2	1.1	1	61	1.0	12	26
Nov. 18	1.3	0	8	1.3	2	48	0.8	0	8
Dec. 16	1.7	0	11	1.6	13	46	(f)	--------	--------
1932									
Jan. 8	2.3	1	16	1.6	6	42	(d)	(d)	(d)
Jan. 22	2.7	3	14	2.8	4	69	(d)	(d)	(d)
Feb. 5	2.8	16	2	3.5	94	0	(d)	(d)	(d)
Feb. 19	3.8	60	2	4.2	90	0	(d)	(d)	(d)
Mar. 4	3.9	14	0	4.0	40	0	6.0	11	0
Mar. 18	5.2	22	0	5.5	26	0	5.4	58	0
Apr. 1	4.6	47	0	4.9	128	0	5.7	154	0
Apr. 15	4.3	34	0	4.6	85	0	4.9	3	0
Apr. 29	5.0	5	0	6.0	63	0	6.0	2	0
May 20	4.6	55	0	4.9	40	0	6.0	5	0
June 22	3.4	63	0	2.8	64	0	2.4	0	0
July 15	3.2	74	0	3.1	137	0	2.3	66	0
Total	--------	448	74	--------	946	637	--------	412	134

[d] No collection. [e] Ponds C-4 and C-3 continuous. [f] Pond drained and cleaned.

ANOPHELES BREEDING IN THE SALT AND BRACKISH-WATER PONDS

The almost complete elimination of *Anopheles* larvæ from the ponds in August gave an opportunity for a comparison of the oviposition tendencies of the two species and, as expected, the subsequent records showed a rapid increase in *A. indefinitus* larvæ. In addition, the observations led to two conclusions; first, that *A. litoralis* will oviposit in brackish or even fresh water when large numbers of adults are present and no other water is available; and second, that the larvæ are able to develop in such water. Of more especial interest, though, is the strong indication that the species is strictly salt-loving

TABLE 4.—*Salt content and collections of Anopheles larvæ in individual ponds*—Continued.

Date.	C–2 (ditch).			C–1 (ditch).			C–0 (ditch).			Other ponds.		
	Salt content.	Larvæ.		Salt content.	Larvæ.		Salt content.	Larvæ.		Salt content.	Larvæ.	
		A. litoralis.	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*		*A. litoralis.*	*A. indefinitus.*
1931	*P. ct.*			*P. ct.*			*P. ct.*			*P. ct.*		
July 27	------	------	------	------	------	------	------	------	------	[h]3.1	3	0
Sept. 24	------	------	------	1.3	4	3	------	------	------	------	------	------
1932												
Mar. 4	3.2	8	0	2.7	15	0	6.7	28	0	------	------	------
Mar. 18	4.5	22	0	2.8	76	0	7.3	44	0	------	------	------
Apr. 1	4.4	37	0	4.2	95	0	8.8	75	0	------	------	------
	[g]7.0	146	0	------	------	------	------	------	------	------	------	------
Apr. 15	4.8	51	0	3.7	40	0	8.8	44	0	------	------	------
	[g]5.0	0	0	------	------	------	------	------	------	------	------	------
Apr. 29	6.0	100	0	4.8	109	0	4.6	76	0	[i]4.2	101	0
May 20	6.0	0	0	4.8	35	0	------	------	------	[j]4.6	149	0
June 22	3.0	80	0	------	------	------	3.7	0	0	------	------	------
July 15	2.8	24	0	------	------	------	3.1	0	0	------	------	------
Total	------	468	0	------	374	3	------	267	0	------	253	0

[g] From pond. [h] Pond B. [i] Pond A–3. [j] Pond P–1a.

and would not maintain itself indefinitely under these conditions. Table 3 shows that, after a partial resumption of breeding, the larvæ gradually decreased until they had nearly disappeared, and were not found in abundance until the salt content in some of the ponds reached about 3 per cent. On another occasion, later in the season, when the concentration ponds were again breeding *litoralis* in numbers, the sudden appearance of the larvæ in pond A–1, where the water contained only a small amount of salt, may be attributed (if the record is not in error) to the cleaning out of the algæ in the salt ponds, which occurred at about this time in preparation for the manufacture of salt.

At the beginning of the study no feasible method of accurately determining the comparative abundance of the larvæ was found, since the counting of larvæ per dip or per unit area was not applicable to the conditions. A small clump of algæ might be the only breeding spot in a large area and contain very many larvæ per square foot, whereas a pond half covered with algal mats would ordinarily have more-scattered breeding but a much greater total output. In making the

collections, therefore, the attempt was made mainly to obtain a fair sample of the larvæ present.

In Table 3 the data have been arranged to show the total numbers of each species collected throughout the season and the average number per collection in the ponds where the collecting was carried out more or less uniformly. The rates per collection have been charted in text fig. 2 for comparison with the maximum and minimum salt percentages to show the general trend of conditions. The increase and decrease shown from one collection to another, however, may or may not accurately represent changes in the amount of breeding. The almost constant decrease in number of *Anopheles indefinitus* larvæ between October 4 and November 18 was not, apparently, an actual decrease in the total number of larvæ, since the notes for nearly all the collections during this period state that larvæ were plentiful. It probably does, nevertheless, represent a significant decrease in the number of fourth-instar larvæ and pupæ, since the younger larvæ were not identified, and no especial effort was made to rear these through to maturity in the laboratory. The plant growths found in the fresher water were not as a rule sufficiently thick to give complete protection, and the change perhaps reflects the effect on the larger mosquitoes of an increase in small fish and other natural enemies. The drop in number between October 4 and 14 was due mostly to the decrease of larvæ in pond C–4, for which the notes give no explanation. This is also the case for certain other variations in individual ponds. The sharp rises of the curves for both *Anopheles litoralis* and *A. indefinitus* April 1 and for *litoralis* July 15 were probably due, in part at least, to the collection of unusually large samples.

The rapid increase in *A. litoralis* breeding after January 22 is clearly correlated with increases in salt percentages. The line representing the increase crosses the maximum-salt-percentage line at about 3.3 per cent, and general increased breeding of this species probably began at about 3 per cent. After breeding had been resumed in the salt ponds, larvæ appeared in one of the brackish ponds (A–2) at less than 2 per cent and, as previously mentioned, another pond (A–1) showed a sudden influx of *A. litoralis* with only 0.9 per cent salt.

The falling line representing the decrease of *A. indefinitus* between April 1 and 15 crosses the minimum-salt-percentage curve at about 2 per cent. On the latter date one of the two remaining brackish-water ponds had become almost dry, the

other one (A–1) showing an increase in salt percentage to 2.3, from 1.4 April 1.

The maximum salt percentage at which larvæ of *Anopheles litoralis* were found breeding was 8.8. This occurred in the ditch at the edge of the salt-bed pond (C–0) April 1 and again April 15, and on both occasions the larvæ and pupæ were normally active. The absolute tolerance of the species for salt was not determined. A reading of 9.2 was recorded in pond A–2 May 20, and on this occasion larvæ were not present, but they had also been lacking in the pond at the time of the previous collection when the salt content was 6.6 per cent. Algæ, principally *Lyngbya majuscula* with a little *Chaetomorpha,* were plentiful on both dates.

In this connection it is of interest to note that the larvæ in the higher concentrations showed a curious thickening or encrustation of the epidermis. The larval hairs also appeared to be more brittle, and the specimens usually arrived in the laboratory with hair tufts and float hairs broken off.

Larvæ of *A. indefinitus* were taken on one occasion at a salt reading of 3.0 per cent and another time at 3.8. At both times the ponds were gradually evaporating, indicating that a small proportion of the larvæ could tolerate percentages above 3 under such conditions. So far as these records are concerned, breeding of *indefinitus* was completely interrupted for at least two months and no other breeding place for the species in this vicinity was known to us.[6] Nevertheless, adults were evidently on hand to restock the ponds as soon as conditions became favorable.

As a further comparison of the distribution of the two species, Table 5 shows the average number of specimens identified and the number of times that each species was taken at different salt percentages.

SUMMARY

In connection with a study of *Anopheles litoralis* King and *A. indefinitus* Ludlow, the two Philippine species of *Anopheles* that breed in salt water, larval collections were made in a series of ponds near Manila over a period of twelve months. The data obtained show that the optimum breeding conditions for each species occur at a different range of salt concentra-

[6] *Anopheles indefinitus* is commonly found in strictly fresh-water breeding places, inland. This phase of the subject has been discussed in the article by King previously cited.

TABLE 5.—*Number of collections and average numbers of the two species of Anopheles at different salt percentages.*

Salt content.	Number of collections containing—				Average per collection.[a]	
	A. litoralis only.	Both species.	*A. indefinitus* only.	No larvæ.	*A. litoralis*.	*A. indefinitus*.
Per cent.						
0.0–0.9	1	10	30	4	4.9	43.3
1.0–1.9	1	22	6	5	22.5	36.8
2.0–2.9	7	5	1	1	42.9	7.9
3.0–3.9	13	2	0	1	65.5	0.7
4.0–4.9	21	0	0	----------	71.8	0.0
5.0–5.9	6	0	0	1	66.8	0.0
6.0–6.9	8	0	0	2	52.8	0.0
7.0–7.9	2	0	0	----------	95.0	0.0
8.8	2	0	0	----------	59.5	0.0
9.2	0	0	0	1	----------	----------
Total or average	61	39	37	15	36.7	21.6

[a] The averages were figured from the number of collections containing larvæ of either species.

tions, which in turn vary with the seasons. This accounts for the marked seasonal fluctuations in the abundance of the two species.

Anopheles litoralis is predominant during the dry season, when the salt concentration is high, and is strictly a salt-water breeder, doing best in water containing upwards of about 3 per cent. Below this point breeding tends to diminish sharply and, although larval development took place under certain conditions in water containing less than 2 per cent salt, the evidence points to the probability that the species would ultimately become eliminated at low salt concentrations. During the rainy season the larvæ were gradually reduced almost to the vanishing point, and after the beginning of the dry season general increased production was not resumed until the salt content reached a point between 2.5 and 3.0 per cent.

The maximum salt concentration in which breeding of *A. litoralis* was found was 8.8 per cent. This was recorded twice, and on each occasion fairly large numbers of normally active larvæ and pupæ were present. Larvæ in the higher concentrations had a curious thickening or encrustation of the epidermis.

During the rainy season *A. indefinitus* becomes the predominant species, and the breeding of this mosquito is very largely limited to brackish and fresh water. At a time when the salt concentration was being gradually increased by evaporation, a

few larvæ were taken from water containing as much as 3.8 per cent, but in general the tolerance of the species is considerably less than this. Breeding in the ponds was entirely suspended for two months during the height of the dry season. After the beginning of the second rainy season, the larvæ reappeared in the first ponds showing a drop in salt content below 2 per cent.

The two principal kinds of algæ found in the salt-water ponds were *Chaetomorpha* sp. and *Lyngbya majuscula.* These formed large floating mats, especially in the salt-concentration ponds and fishponds, and flourished in water containing as much as 9 per cent of salt. The growths usually contained *litoralis* larvæ, but both kinds of algæ persisted to some extent after the ponds had been much diluted by rains and were then associated with *indefinitus* breeding. A third species of algæ, *Lyngbya aestuarii,* appeared to thrive best in water of lower or intermediate salt concentrations and disappeared from the ponds during the latter part of the dry season. Large mats were found when conditions were favorable. A fourth species, *Enteromorpha tubulosa,* was rather frequently recorded, being found at one time or another in each of the ponds and under a wide range of salt percentages. This species does not, however, form extensive growths and was much less important in connection with mosquito breeding.

In brackish-water ponds the most typical plant growth was a *Chara*-like plant belonging to the frogbit family (Hydrocharitaceæ). In water of low salt content it frequently developed luxuriant and extensive growth with the tops of the plants, resting just at the water surface, harboring large numbers of *Anopheles indefinitus* larvæ. The limit of salt tolerance of this plant species seemed to be between 2.5 and 3.0 per cent.

ILLUSTRATIONS

[The photographs, with the exception of Plate 2, were taken June 27, 1932, when the ponds were filled with water.]

PLATE 1

The series of concentration ponds, photographed from the edge of salt bed C–0.

PLATE 2

One of the paved salt beds from which salt is collected after evaporation of the sea water.

PLATE 3

One end of pond C–4 with scattered mats of algæ, *Lyngbya majuscula* and *Chaetomorpha* sp.

PLATE 4

Brackish-water pond A–1, the smallest of the ponds in the series. The pond contained a growth of the *Chara*-like plant, which is hardly visible in the photograph.

PLATE 5

Pond A–2, showing a large mat of algæ consisting almost entirely of *Lyngbya majuscula.*

PLATE 6

A portion of fishpond P–2, with a large mat of algæ in the foreground. Pond P–1 lies just beyond the dike at the far end.

PLATE 7

Pond P–1, flooded from June rains. A few tufts of grass and, in places, the tops of the *Chara*-like plant are visible.

TEXT FIGURES

FIG. 1. A sketch of the ponds where *Anopheles*-breeding studies were made, showing their approximate size and location.

2. The salt content and the seasonal abundance of larvæ of *A. litoralis* and *A. indefinitus* in six ponds under observation from July, 1931, to July, 1932. The circles on the lines representing maximum and minimum percentages of salt do not coincide with the dates of observation, which were the same as those for the larval collections.

PLATE 1.

PLATE 2.

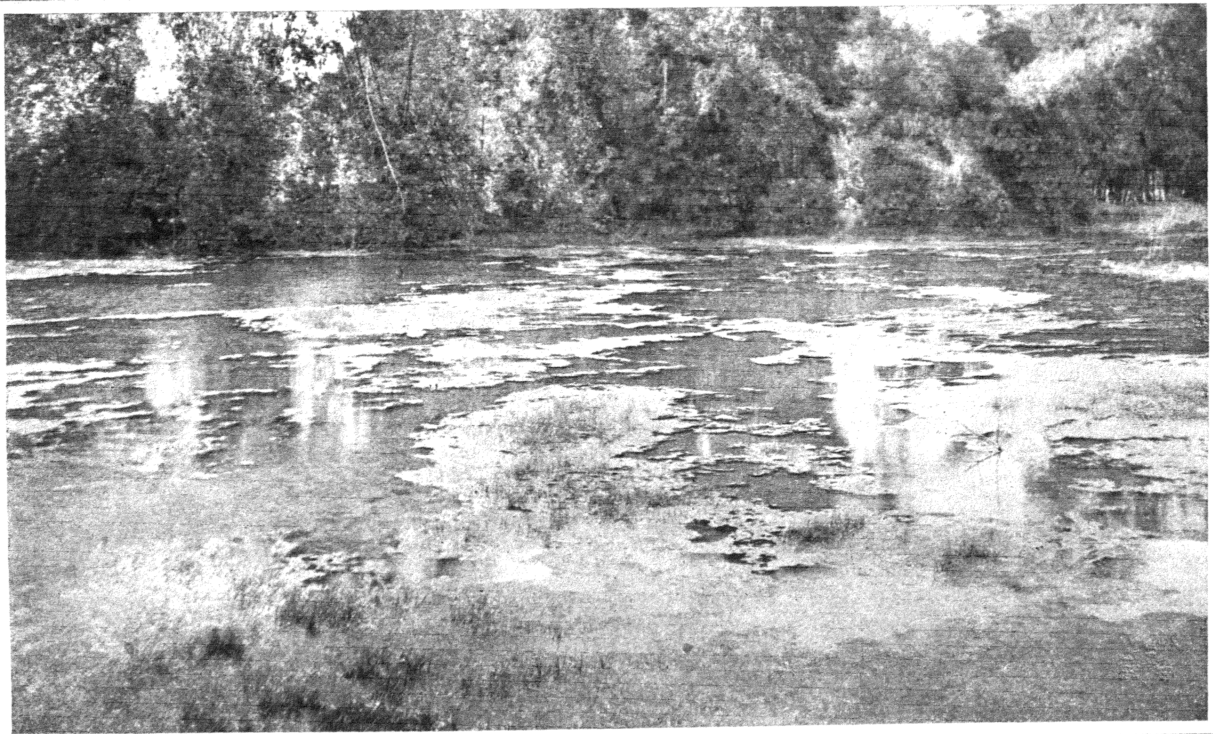

PLATE 3.

PLATE 4.

PLATE 5.

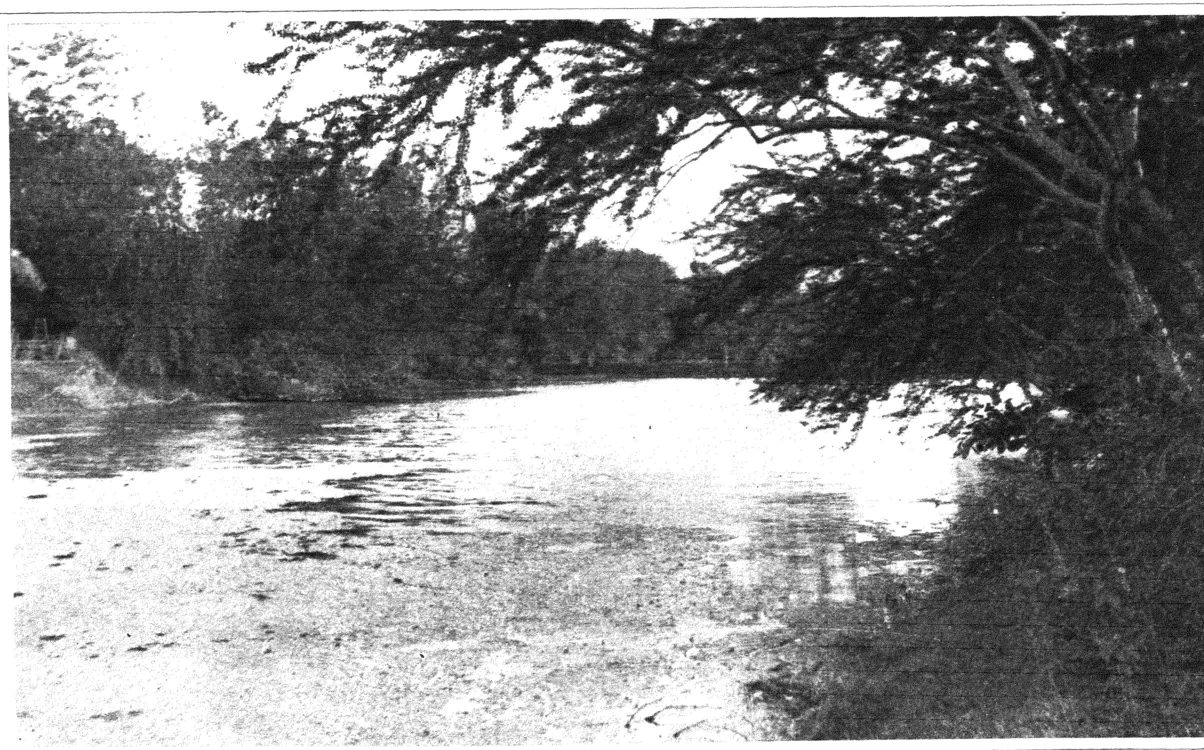

PLATE 6.

PLATE 7.

NEW OR LITTLE-KNOWN ORIENTAL THYSANOPTERA

By H. PRIESNER

Of the Ministry of Agriculture, Cairo, Egypt

This paper is based on material forwarded to me by Dr. R. Takahashi, of the Taihoku Agricultural Experiment Station. Most of the species were collected by Doctor Takahashi, who has contributed much to our knowledge of tropical Thysanoptera.

THRIPIDÆ

HERCINOTHRIPS ERRANS (Williams).

Male (*hitherto unknown*).—In every respect very similar to the female but slenderer; abdomen narrow, tapering from segment 1 or 2 caudad; the dorsal longitudinal pits at base of tergites as in the female; segments 7 and 8 each provided with a dotlike glandular area, the width of which is 16 and 22 μ, respectively. Tergite 8 with a long comb, which extends considerably beyond base of tergite 9; this segment longish, dorsal length, 140 μ; width beyond base, 136 μ; netlike sculpture of tergite 9 largely developed, particularly near the fore angles; dorsally and mesally the tergite bears two pairs of spines and two pairs of bristles; length of anterior pair of spines, 36 to 40 μ, of posterior, about 28 μ; posterior spines closer to each other than anterior; the two pairs of dorsal bristles situated near the sides of posterior spines; a short longitudinal furrow between anterior spines; between the posterior spines, however, there are eight to ten chitinous wartlets; tergite 10 consists of two rhomboidal plates. Measurements of the antennæ from joint 2: 42, 62 to 64, 56, 43, 28 to 29, 11, 28 to 29 μ.

FORMOSA, Kahodai, June, 1933 (*R. Takahashi*).

SERICOTHRIPS TABULIFER sp. nov.

Belonging to the group having two-colored abdomen, and margins of prothorax with netlike structure.

Female.—Much shaded; more or less dark brown as follows: Head, central plate of prothorax, femora (except extreme base and apex of fore and middle femora), notal plates of pterothorax (where not reticulated), mesosternum, metasternum, coxæ, a

small lateral plate on each of tergites 2, 3, and 6, and segments 7 to 9 and base of segment 10 of the abdomen. Pale yellow as follows: Entire tibiæ and tarsi; joints 1, 2, and 3 of antennæ; joint 3 sometimes very faintly shaded, 4 slightly shaded in apical half or third, 5 shaded about the apical half, 6 pale at base, the remainder of 6 and joints 7 and 8 slightly shaded; abdominal segments 4 and 5 pale yellow; segment 10 yellow, somewhat shaded; segments 2, 3, and 6 (excepting their dark dorsolateral plates) only slightly darkened; wings much darkened but with pale subbasal band. Bristles of the body shaded. Ocelli red, eyes black.

Head strongly transverse, its base almost behind the eyes, netlike space of hind margin of vertex extremely narrow, almost wanting. Length of eyes, about 60 μ. Bristles on head fine but distinctly visible; postocular series exactly on hind margin of vertex; interocellar bristles in front of hind ocelli. Length of head, 78 μ; width, 165. Antennæ very slender; measurements of joints: 24 (28), 36 (25), 76 (17), 68 (16), 44 (15), 56 to 60 (14), 10 (6), 12 (3) μ; joint 3 elongately bottle-shaped, but neck not narrowed at extreme apex—that is, not concave—joint 4 similar, both with long forked trichomes, length (on joint 3) 60 μ; joint 6 not constricted at base, with a long, narrow, pale longitudinal area, style very slender. Pronotum length (including netlike part), 96 to 100 μ; breath, about 190; polygonal reticulation of anterior and lateral parts dark, areas between meshes pale yellow; length of the anterior reticulated part, 36 μ—that is, 0.36 of the pronotal length—reticulated area with thin bristles on fore margin, the innermost longest, 24 to 26 μ; strongly chitinized, transversal dorsal plate of pronotum about 160 μ wide, and 60 to 64 μ long, with dense cross wrinkles, its fore angles about rectangular, not protruding—not as, for instance, in *S. ramaswamiahi* (Karny)—and its fore margin not deeply but only slightly emarginate; fore margin of reticulated part entirely straight; fore margin of dorsal plate set with well-developed but tender bristles (26 to 28 μ), a long angular bristle (about 36 μ) on the hind angle of the plate, at the hind margin; within, a distinct bristle. Pterothorax width, about 225 μ. Sternum, mesosternal metasternal plate, and coxæ smooth, in contrast to pleuræ, which are reticulated; mesoscutum densely cross-wrinkled, metascutum smooth. Abdomen peculiar in structure; slightly shaded tergites 1 to 3 densely set with microsetulæ and in addition a lateral, approximately semielliptical plate, the fore margin of which is sharply

lined with black; tergites and sternites 4 and 5 colorless, in contrast with segment 6, which is as in 2 and 3; 7 to 9 uniformly dark, with a more or less dark line on fore margin; segment 10 paler again. Bristles on segment 9 moderately long, bristle 2, 52 μ; on segment 10, about 60. Upper vein of the narrow forewings with 21 to 24 bristles; imaginary lower vein has no bristles. Total body length, distended normal, 0.98 mm.

FORMOSA, Loochoo (Oriomote), July 20, 1932, on *Glochidion* (?), 1 female (holotype) (*S. Minowa*).

This new species is closely allied to *S. circumfusus* Priesner, but differs in that in the latter the pale fore margin and lateral part of the pronotum are not reticulated but transversely striated, and the dorsal plate bears a greater number of bristles. Moreover, the bristles on the abdomen are longer, the antennæ darker, and their joints shorter. *Sericothrips ramaswamiahi* (Karny), another related species, has not polygonal, but transversely much distended, meshwork, and the head shows a pale, reticulated occipital portion, while the fore angles of the dorsal plate of the pronotum protrude hornlike. *Sericothrips occipitalis* Hood has the occiput reticulated, and the anterior part of the pronotum is more as in *S. ramaswamiahi,* and the fore margins of tergites 2, 3, and 6 are provided with a complete, uninterrupted, dark line. All the other species of this genus are quite different.

The new species is no doubt closely related to species of *Hydatothrips* Karny and *Neohydatothrips* John. The former genus will always be doubtful; it is based on a mutilated specimen; the latter genus is distinguished from *Hydatothrips* and *Sericothrips* only by the alleged characteristic striation of tergites 1 to 5 (microsetulæ?); in any case, *Neohydatothrips latereostriatus* John is easily distinguished from this new species by the much shorter antennal segments.

DENDROTHRIPS MINOWAI sp. nov.

Female.—Reddish brown, with irregular brown shadings; red pigment profusely developed but for a broad median longitudinal line, and the three terminal segments, which are free from red cells, less heavily chitinized and, therefore, paler; margins of vertex paler around eyes, undulated hind marginal line of vertex blackish, segment 10 of abdomen paler than 9; forelegs lighter than middle and hind legs, the former grayish yellow-brown, margins of tibiæ darker, particularly from middle to tip, lighter at base; middle and hind femora dark, darker than head and

prothorax; tarsi pale yellow to pale yellowish gray; antennal joint 1 grayish yellow exteriorly, 2 shaded, 3 to 5 pale yellow, 5 shaded in distal half or at apical margin, the following joints dark. Forewing, including scale, deeply shaded with gray, with a single colorless band before middle, separating a dark basal part about 208 μ long, from a hyaline portion 120 μ long; the remainder about 390 to 400 μ. Bristles pale.

Head strongly transverse, length from eyes, 80 μ; entire length, 88; width, 156; width of interantennal projection, 12 to 14, the latter truncate in front; head between the eyes with a double excavation; cheek narrowed posteriorly; length of eyes, dorsally, 64 to 68 μ; laterally, 60; facets coarse, intervals hardly pilose; a less strongly chitinized, transversally wrinkled, postoccipital part separated from the vertex by a dark crossline; no conspicuous bristles on head; two very small pores on either side in front of the posterior ocelli, suggesting vestigial bristles. Mouth cone very short, and broadly rounded, maxillary palpi most probably two-segmented. Antennæ short, about 200 μ; measurements of joints, as follows: 14 to 17 (25), 34 (25 to 27), 36 (15), 32 (15), 34 (16), 27 to 28 (11), 8 (5), 8 (3) μ; joint 1 somewhat widened towards apex; 2 barrel-shaped, narrowed, basally and apically, more noticeably convex interiorly than exteriorly, transversely striate, bearing microsetulæ; joints 3, 4, and 5 slender, 3 with thin stalk, sense cones on joints 3 and 4 small, simple; joint 5 thicker and longer than 4 and much stouter than 6; this joint spindle-shaped, style slender, thin; sense cone of joint 6 long and thin, surpassing tip of antenna. Prothorax strongly transverse, length, about 92 μ; width, 183; fore margin straight, hind margin somewhat rounded; surface without any particular structure, irregularly and obsoletely rugose. Prothorax without conspicuous bristles. Legs, especially fore tarsi, short. Width of pterothorax, 225 to 232 μ; length of wings, 0.73 to 0.74 mm; shape of wings as in other species of this genus, hind margin straight; fore and hind margins fringed, but fringe developed on the former from the white crossband only; thus about the basal third of the wing remains free from fringe hairs; these hairs inserted on fore margin, not at the edge itself, but somewhat remote from it, at the lower surface of the wing; only one inconspicuous longitudinal vein; hind wings very narrow. Abdomen with dorsal longitudinal furrow from segment 2 to 7, in which is situated the usual pair of bristles; laterally, on both sides of this furrow, surface transversely striate, the faint crosslines provided with extremely small

granules, representing microsetulæ of other genera. Bristles on segment 9 short, directed backward; median pair on segment 8, 52 μ in length, in contrast with the four posteromarginals of tergite 9, which are only 44 to 48 μ; bristle 1 of segment 10, 30 to 32 μ; bristle 2 shorter. Total body length, 0.89 to 1.03 mm. There are specimens with abnormally seven-segmented antennæ.

JAPAN, Kirishima, July 30, 1932; host plant unknown (*S. Minowa*).

This species is characterized by the coloration of the forewings (deeply shaded, with one white crossband), and further separated from all known species by the chætotaxy and the shape of the antennal joints.

ANAPHOTHRIPS FLAVICINCTUS Karny forma BRACHYPTERA f. nov.

The antennæ fully agree with those of forma *macroptera;* the legs, particularly the forelegs, are somewhat paler than in *macroptera.*

FORMOSA, Shinten, December 27, 1933, on a grass halm (*R. Takahashi*).

TÆNIOTHRIPS OREOPHILUS sp. nov.

Belonging to the group containing *T. major* Bagnall, *alticola* (MS), and *montivagus* (MS), all of them having the eyes strongly protruding.

Female.—Dark brown, with red pigment profusely developed, pale specimens, however, grayish brown, with thorax tinged with orange; femora dark, fore and middle tibiæ gray-yellow, or yellow and more or less shaded along margins, hind tibiæ pale yellow, only sometimes faintly clouded at margins; antennæ with joints 1, 2, and 6 to 8 dark, 3 pale yellow (not shaded), 4 and 5 pale yellow in basal third or half (joint 5 abruptly shaded in distal portion); body bristles dark. Wings dark gray-brown, with a broad subbasal colorless area, and a noticeable lighter area about the middle or beyond, as in *T. picipes* Zett.

Head longish, length, from eyes, 165 μ; total, 190; antennæ situated on a short prominence before eyes, width of head, across eyes, 165 μ; behind, 163; eyes strongly protruding, pilose, head strongly constricted behind eyes, anteocellar bristles at the sides of the anterior ocellus moderately long, interocellars close together (distance, 10 μ), situated approximately on a line connecting fore margin of hind ocelli, length, about 90 μ, postocular series well developed, the two innermost almost horizontal, bristle 4 longest, 32 to 36 μ; mouth cone normal. Length of an-

tennæ, 450 μ; measurements of joints: 39 (38), 50 (31), 90 to 91 (28), 93 to 94 (25), 52 to 53 (21), 78 to 80 (22), 14 (9), 20 to 21 (6) μ; antennæ much slenderer than in *picipes*, sense cones very long, about 64 to 68 μ on joint 4, joint 3 constricted before apex, when seen from above, but its neck not very long, 4 somewhat vasiform; sense cones on joint 6 slender. Length of prothorax, 155 μ; width, 225; posteroangular bristles long, curved, 120 to 132 μ; three pairs of posteromarginals, the innermost of which is three times as long as the two others, fully 48 μ, and somewhat remote from hind margin, while the others are placed on the margin itself; bristles on disk scarce. Fore tarsi unarmed. Width of pterothorax, 320 to 346 μ; wings, length, 1.33 mm; ensiform, with 32 to 34 bristles on costa, 3 + 6 (or 4 + 6) basal and 1 + 2 (or seldom 2 + 2) distal bristles on the upper vein, and 13 to 16 bristles on the lower vein. Tergite 8 with complete, very long comb; segment 9, dorsal bristles, 88 to 100 μ; posteromarginals, 148, 172, 172 μ; tergite 10 split above up to the insertion of the bristles; bristle, 172 to 176 μ; sternites without accessories. Total body length, much distended, 2.07 mm.

FORMOSA, Mount Ari, April 25, 1931, 1 female holotype and 4 female paratypes (*S. Minowa*); Murorafu, August 15, 1934, female paratypes; Matsumine, Taichu-Shu, female paratype (*R. Takahashi*).

Very close to *T. montivagus* (MS) and *T. alticola* (MS), but easily distinguished from either by the abruptly yellow basal part of joints 4 and 5 of the antennæ and by the yellow tibiæ.

TÆNIOTHRIPS (CRICOTHRIPS) SMITHI Zimmermann.

ZIMMERMANN, Bull. Inst. Bot. Buitenzorg 7 (1900) 10, fig. 2.

Female.—More or less dark gray-brown, with rich crimson pigmentation; antennæ blackish, except joints 3 and 4, which are abruptly whitish at base and at the constricted apical portion, and joint 5, which is so at base only; tarsi yellow; fore tibiæ yellow, except their dark base; middle and hind tibiæ pale yellow in distal half or the latter yellow in distal two-fifths only. Bristles of body dark; forewings dark, with a large, subbasal, pale patch, which is, however, not quite colorless.

Head length, medianly, 165 μ; from eyes, 138; width, across eyes, 182; across cheeks, 190; cheeks almost parallel or somewhat widened posteriorly; vertex very closely transversely striate; eyes, laterally, 88 to 92 μ; dorsally, 96; not bulging,

somewhat longish in appearance; interocellar bristles in normal position (situated on the tangent), moderately long (28 μ); postocular series, none of which is particularly prominent, close to hind margin of eyes, horizontal, the two innermost bristles situated behind hind ocelli. Length of antennæ, 415 μ; measurements of joints: 20 (36 to 38), 42 (31 to 32), 93 to 95 (31), 106 (29), 56 (20), 62 to 64 (17 to 18), 11 (8), 17 (6) μ; joint 1 strongly transverse, 2 normal, 3 and 4 very long, bottle-shaped, with a long necklike apical part, and very long sense cones (88 to 96 μ), which reach the middle and the terminal third of the following segment, respectively; sense cones on joint 6 slender; joint 5 even somewhat broader than 6, broadest at apex, while 6 is broadest at base, and very little longer than 5; base of joints 4 and 5 as in *Cricothrips* Trybom. Length of pronotum, 155 to 173 μ; width, 216 to 240; disk of pronotum transversely striate as the vertex; a single long posteroangular pair of bristles (the inner), about 76 to 80 μ; the outer pair does not exceed 28 μ, and is not longer than the anteroangular and laterals; disk well set with small bristles; two pairs of posteromarginals are noticeable, the innermost of which is about 36 μ in length. Width of mesothorax, 311 to 360 μ. Wings, length about 0.95 mm; ensiform, broad near base but much narrowed beyond (130: 52); upper vein with numerous (3 or 4 + 7; 4 + 6) basal, and 1 + 2 distal bristles, lower vein with 13 to 17 bristles, costa with about 30. Accessory bristles wanting on sternites; a long, complete comb on tergite 8. Bristles on segment 9, dorsals 68, posteromarginals 132 to 136, 160, 160 μ; those on segment 10, 148 to 152, 144 μ; segment 10 not divided above. Total body length (distended), 1.67 mm.

FORMOSA, Hori, June 6, 1933, 1 female; August 9, 1934, 2 females in orchid flower (*R. Takahashi*). Previously known from Java.

This is one of the few species of the genus *Tæniothrips* having only one well-developed bristle at the hind angles of the prothorax; the dark basal ringlet of each of antennal joints 4 and 5 also suggests *Cricothrips* Trybom, a genus which is not yet definitely characterized and well separated from *Tæniothrips* sens. lat., since, in the above character, there are gradations from *Tæniothrips* to *Cricothrips*. Moreover, the chætotaxy of the prothorax brings the species close to *Oxythrips*, and I should not wonder if it would be described once more under the latter genus.

TÆNIOTHRIPS SULFURATUS sp. nov.

Female.—Pale yellow, thorax and extreme tip of abdomen conspicuously tinted with orange, exactly as in *Thrips flavus* Schrk., no trace of gray shades on the body; eyes dark purple, ocelli crimson, bristles on the body dark. Wings almost colorless, very faintly shaded with yellow; legs yellow. Antennal joints 1 and 2 pale yellow, the latter often with orange (not grayish), the following clouded with gray, 3 yellow about the basal third or basal half, 4 uniformly or only basally yellow, 5 yellow in basal half, 6 dark or somewhat paler at base, style dark.

Very similar to the eight-segmented form of *T. flavus*,[1] so that the bristles of the head are equal in length and position, only the disk bristles of the pronotum are set more densely and closely than in *T. flavus;* hind angular bristles, about 80 μ long (100 to 105 μ in large specimens of *T. flavus*) ; hind margin with three pairs of smaller bristles, the innermost, 36 to 40 μ, as in *Thrips flavus.* Width of mesothorax, 240 to 286 μ; length of wings, 0.81 to 0.95 mm. Costa with about 30 bristles, upper vein with 7 basal and 1 + 2 distal bristles, lower vein with about 15 to 16 bristles. Antennæ somewhat more slender than in *T. flavus,* thus they differ not only in their color. Antennæ with style very short, joints 7 and 8 little different in length; measurements of joints from joint 2: 45 (25), 67 (20), 62 to 66 (18), 45 (18), 64 to 66 (19), 6 (7), 7 (6) μ; a smaller specimen has joints 3 to 5, 56, 42, and 55 μ, respectively. No accessory bristles on the sternites; tergite 8 with complete comb; bristles on segment 9, bristle 1, 92 μ; bristle 2, 112 to 120; bristle 3, 104 to 108; segment 10, bristle 1, 120 μ; bristle 2, 112 (bristle 1 of segment 9 much longer in *T. flavus*).

FORMOSA, Taihoku, May 3, 1933, female, holotype, on *Clerodendron;* November 25, 1933, females, paratypes, on *Camellia;* Matsumine, Taichu-Shu, August 12, 1934, female, paratype (*R. Takahashi*).

[1] Bagnall, Ent. Mo. Mag. 44 (1928) 98, described a *Physothrips flavus,* which is distinguished from *Thrips flavus* Schrk. only by the two-segmented style. This, however, cannot be a new species of *Tæniothrips* (*Physothrips*), but must be a regressive form of *Thrips flavus* and has to be dealt with as such, and a new name has to be created for it (for example, *biarticulata*) or it has to be mentioned as "forma," even without a special name, with *Thrips flavus* Schrk. When making a key for the species of *Tæniothrips* (*Physothrips*), one has, of course, to include this form of *Thrips flavus*, but under the latter name; not as *Tæniothrips.*

BOLACOTHRIPS ORIENTALIS sp. nov.

Male.—Light yellow, eyes dark purple, testicles orange; legs pale yellow, joints 1 to 4 of the antennæ pale yellow, joint 5 grayish, paler towards base, 6 and 7 dark. Bristles almost colorless.

Head, length, 124 μ; from eyes, 108; width across eyes, 112 to 120; eyes, length about 56; fore angles of eyes somewhat distant from base of antennæ; ocelli not noticeable, apparently absent; interocular bristles well developed, about 28 to 32 μ in length; a small anteocular near fore angles of eyes; a very small posterior interocellar bristle, hardly longer than the inner postocular bristle; there are only two pairs of postoculars discernible, the inner of which is very minute, the outer, however, very well developed, about 32 to 36 μ; mouth cone as usual; length of antennæ, 225 μ; measurements of joints: 18 to 20 (25), 34 (22), 36 (17), 31 to 32 (15), 34 to 35 (14), 45 to 46 (15), 15 to 17 (8) μ; joint 1 convex laterally, the sense cones on segments 3 and 4 apparently simple, joint 5 broad at apex, 6 little rounded laterally. Prothorax narrow, 112 to 120 μ in length, 132 μ in width; bristles tender, bristles 2 of fore margin 24 to 28 μ, posteroangulars 56 to 60 and 40 to 44 μ; three pairs of posteromarginals, the innermost 15 to 20 μ. Pterothorax width, 148 μ; wings reduced to small scales, bearing five costal (marginal) bristles; segment 9 of the abdomen with very long bristles: there is one dorsal pair of about 116 to 120 μ, while a posterior median pair measures not more than 36 to 40 μ; bristle 2 (lateral) is even 136 μ. No comb on tergite 8. Sternites 3 to 7 with large and broad glandular areas (width, 72 to 76 μ; on segment 7, 68 μ), the fore margins of which are nearly straight, the hind margins somewhat emarginated. There are accessory bristles behind the glandular areas, being most numerous (6 or 7) on segment 6, least (2) on segment 5.

FORMOSA, Taihoku, August 4, 1934, 1 male, on onion (*R. Takahashi*).

This species is very similar to *B. jordani* Uzel, but differs in the shape of the antennæ and their coloration, the broader glandular areas, and the chætotaxy of tergite 9, of which the innermost pair of bristles is much smaller than the outwardly following one, while in *jordani* the first (innermost) pair is longest (120: 32 μ). The female is unknown.

PHLÆOTHRIPIDÆ

LIOTHRIPS HEPTAPLEURINUS sp. nov.

Female.—Black, middle and hind tarsi gray-brown, fore tarsi pale yellow, fore tibiæ brown-yellow, somewhat shaded at margins towards base; joints 1 and 2 of antennæ dark, 2 yellowish brown towards apex (outwardly), 3 to 6 clear yellow, 6 scarcely noticeably clouded towards tip or wholly yellow, 7 and 8 pale brown, 7 almost clear at base. Wings colorless, with a faint longitudinal streak, reaching the distal third. Bristles of body black, much paler on segment 9.

Head, length, about 277 to 310 μ; breadth, 200 to 208; cheeks parallel, somewhat constricted at base, head not broader across eyes than behind; eyes laterally 95 μ, the posterior ommata not larger than the others; hind ocelli before middle of eyes, front ocellus somewhat surpassing the fore margin of the eyes. Bristles on body pointed. Postoculars very long, black, longer than an eye. Mouth cone long, pointed. Length of antennæ, 484 to 520 μ; measurements of joints: 40 (bristle 48, t. 38), 60 to 64 (36), 92 to 94 (34), 88 (40), 76 (36), 68 to 70 (34), 62 (28), 38 (15) μ; sense cones, joint 3, 1; joint 4, $1+2^{+1}$; joints 5 and 6, $1+1^{+1}$; joint 3 is 2.6 to 2.7 times as long as broad, 8 narrower than 7 at apex, but not constricted, hardly narrowed towards base. Pronotum, length, 155 to 190 μ; width, including coxæ, 355 to 415; fore angle bristles conspicuous, about 80 μ or more, both pairs of posteroangular bristles 173 to 182 μ, their width at base, 6 μ; length of coxals, 72 to 80 μ; these bristles are sharply pointed. Width of pterothorax, 415 to 485 μ. Bristles at base of wings black, length, about 92 to 96 μ, almost pointed; wings broad, parallel-sided, with 14 to 16 double fringe hairs. Lateral abdominal bristles stout, long, dark; those on segment 9 yellowish, very long, 220 to 240 μ; anals, 220. Tube, length, 260 μ; breadth at base, 100; breadth at tip, 50; conical, sides straight, sometimes more strongly constricted about the apical third. Total body length, 2.55 mm.

FORMOSA, Taihoku, December 23, 1926, on *Heptapleurum* (*R. Takahashi*).

One might compare this species with *Smerinthothrips heptapleuri* (Karny); but the latter species has, apart from the blunt mouth cone, a shorter third antennal joint, shorter legs, and much shorter bristles, and the wings are slightly clouded throughout; there is no other species of *Smerinthothrips* with which it could be confused; from the allied species of *Liothrips* the new

species differs as follows: From *L. oleæ* (Costa) by the longer tube, the striped wings, the longer bristles, and the lighter antennæ; *L. kingi* Bagnall has very short, colorless postoculars; *L. malloti* Moulton has a much shorter tube; and *L. longirostris* Karny has the inner anteroangulars of pronotum vestigial and the wings shaded throughout. There is only one species really similar to *L. heptapleurinus;* namely, an undescribed form from India, collected by Dr. Ramakrishna Ayyar (Coonoor, December, 1927, No. 194), which I have not at hand at present, but I have a short description and the measurements of the antennæ; however, the antennæ are not only absolutely longer but the third joint is more elongate, 3.7 to 3.8 times as long as broad, while it is only about 3 times as long as wide in *heptapleurinus;* the head is 380 (225) μ in length and 225 μ in breadth, the tube 277 μ; the Indian species shows the following measurements of the antennal joints, from 3: 120 (32), 115 (41), 106, 81, 64, 32 μ. It is certainly different.

LIOTHRIPS PIPERINUS sp. nov.

Female.—Blackish brown to black; extreme tip of fore femora, fore tibiæ, all tarsi, and tips of middle and hind tibiæ pale yellow; antennæ with joints 1, 2, 7, and 8 dark, 3 and 4 yellow, 5 yellow, slightly shaded in distal half (or two-thirds), 6 shaded in apical half. Forewings slightly clouded, besides, with a long, dark streak, and with hind margin gray, hind wings with a longitudinal streak, and hind margin shaded.

A large species, with legs and antennæ slender, bristles long and very stout.

Head, length, 380 μ; from eyes, 355; width across eyes, 234; eyes large, 130 to 138; length of cheeks behind them, 225; cheeks converging posteriorly; hind ocelli well before middle of eyes; postoculars stout, dark, blunt, 112 to 120 μ, their distance from the eyes, 44 to 48; mouth cone long and narrow, labrum sharply pointed. Antennæ, length, 623 to 640 μ; measurements of joints: 40 (bristle 48), 68 to 76 (32 to 36), 100 to 108 (32), 112 to 120 (38 to 40), 112 to 120 (32 to 33), 92 to 100 (32), 76 to 80 (24 to 26), 40 to 44 (12 to 13) μ; joint 3 with one long and very slender sense cone, joint 4 with $1 + 2^{+1}$, 5 with $1 + 1^{+1}$; forelegs slender. Length of prothorax, 173 μ; width, 363; including coxæ, 424; bristles very well developed, length of those on hind angles, about 155 to 160 μ; their diameter at base, 8; they are blunt at tips; anteroangulars, about 65 μ. Pterothorax width, 467 to 520 μ; wing, length, about 1.38 mm; bristles at base

of wing dark, 100 μ; bristle 3, 140 μ; the latter almost pointed. Double fringe 17 μ (in a very small specimen, 11; mesothorax, 346). Bristles on abdomen stout, dark, bristles 1 and 2 on tergite 9 sharp, hairlike, 200 to 240 μ, while some of the dorsal bristles of the anterior segments are blunt. Tube regularly conical, length, 260 to 277 μ; width across base, 96 to 100; at tip, 46 to 48; lengths of anal bristles, 260 to 280 μ; dark at base only. Total body length, 2.85 to 2.94 mm.

FORMOSA, Habon, August 10, 1934, females on *Piper;* together with *Smerinthothrips kuwanai* (Moulton); Rarasan, July 31, 1933, on *Piper* (*R. Takahashi*).

The shape of the head, the comparative length of the tube, the color of the antennæ, and the distinct coloration of the wings exclude a great number of species from comparison; *L. oleæ* (Costa) has shorter and stouter legs and antennæ, and other coloration of the latter; *L. hradencensis* Uzel is similar but has the eyes much smaller, head and antennæ less slender, and mouth cone much less acute, bristles thinner, and wings paler; *L. seticollis* Karny is much closer in shape but has antennæ darker, middle and hind tibiæ and tarsi dark, and bristles not so stout; the new species is also quite close to *Smerinthothrips ficarius* (Priesner), but shape of mouth cone and color of tibiæ are quite different; the shape of the extremely stout bristles is about the same as in *Smerinthothrips rubiæ* (MS), from *Rubia cordifolia*, Mount Gedeh, Java, and also the antennæ are similar, but in *rubiæ* they are darker, even joint 3 is somewhat gray at tip, and the tube is different in shape, not evenly conical, and longer, mouth cone blunter.

DOLICHOTHRIPS PUMILUS sp. nov.

Male.—Blackish brown to black; legs dark, middle and hind tarsi shaded with gray, fore tibiæ dark at base and sides, yellowish longitudinally in the middle and at tip; antennæ with joints 1, 2, 7, and 8 dark, 7 sometimes pale at base, intermediate joints (3 to 6) pale yellow. Wings colorless or nearly so.

Head, length from eyes, 190 μ; total length, 202; width, 155 to 165; surface almost smooth (very densely and inconspicuously transversely striated); cheeks almost parallel; length of eyes, 80 μ; cheeks behind them, 120 to 128; hind ocelli situated before the middle of eyes, front ocellus somewhat overhanging; behind the posterior ocelli, at inner margins of eyes, two minute bristles on each side; postoculars very close (6 to 8 μ) to hind margin of eyes, 48 to 52 μ in length, blackish, sharp. Mouth cone acute-

ly pointed, sides concave; maxillary palpi slender. Antennæ, length, 329 to 337 μ; measurements of joints: 22 (bristle 28), 42 (24), 49 (27), 56 (28), 50 (22), 46 (20), 42 (17), 25 (10) μ; joint 1 narrowed towards tip, areola of joint 2 situated near apex, joint 3 more strongly convex inside than on the outer surface, with 1 + 2 sense cones, 4 with 2 + 2 sense cones, 5 with 1 + 1; joint 8 narrower than 7 at apex, but not constricted. Fore femora somewhat enlarged, fore tarsi with a triangular tooth at base; prothorax, length, about 125 μ; width, 234; width including coxæ, 253; bristles moderately long, dark, blunt or open, straight, those on fore margin not more than 28 μ, the posteroangulars, about 40 to 48 μ; coxal, 32, dark, blunt. Pterothorax, width, 294 to 303 μ; wings somewhat narrowed in the middle, basal bristles somewhat shaded, 1, 2 short, 28 to 34 blunt, bristle 3 acute, not longer, 32 μ; double fringe, 6 to 7. Segment 2 of the abdomen broadest, 240 to 277 μ; bristles on segment 9 of the abdomen rather pale, bristle 1, 128 to 132 μ; bristle 2, 20 μ, weak, not spinelike; bristle 3, about 140 μ. Tube shorter than these bristles, length, laterally, 128 μ; dorsally, 122; width, across base, 60; at apex, 32; terminal (anal) hairs about 180 to 188, shaded; tube conical, but somewhat more constricted before apex. Total body length, 1.45 to 1.64 mm.

Female.—Very similar to the male but somewhat stouter, fore tarsi also armed. Head, length, 218 μ; width, 164; mesothorax width, 329. Eight or nine interlocated fringe hairs. Bristles on fore margin of prothorax, 40 μ; those on segment 9 of the abdomen 180, 160, and 152 μ. Tube regularly conical; length laterally, 168 μ; width, basally, 72; across apex, 36; anals, about 200.

FORMOSA, Nisui, November 1, 1928, on *Diospyros discolor* (*R. Takahashi*).

The new species is distinguished from the other species of this genus as follows: *Dolichothrips citripes* (Bagn.), *D. flavipes* (Mlt.), *D. macarangai* (Mlt.), and *D. ochripes* Karny have yellow tibiæ; *D.* (*Dolicholepta*) *jeanneli* Bgn., *D.* (*D.*) *giraffa* Karny [= *micrurus* (Bagnall)], and *D.* (*D.*) *karnyi* Faure have simple fringe; *D.* (*D.*) *varipes* Bagnall has simple fore femora and legs and body, very slender fore tarsi unarmed in both sexes; *D. longicollis* Karny is a much larger species, with longer prothorax and black bristles on segment 9; the new species is very close to *D. indicus* (Hood) (= *Neoheegeria indica* Hood), in which species, however, joint 7 of the antennæ is pale, the postoculars are shorter, joint 4 of the antennæ only 1.8 times as

long as broad; that is, the antennæ are not so slender as in *pumilus*.

SMERINTHOTHRIPS VITIVORUS sp. nov.

Female.—Blackish brown to black, legs dark; tips of middle and hind tibiæ, and the fore tibiæ (except their base) pale yellow, tarsi light yellow. Bristles on head and prothorax blackish, those on the abdomen (excepting those on segments 2 to 4 and the dark anals) yellowish to grayish yellow; antennæ with joints 1 and 2 dark (the latter paler in distal half, exteriorly), joints 3 to 7 pale yellow, 7 diffusedly shaded in apical half or wholly pale, 8 brownish. Wings colorless or very slightly tinged with yellow.

Head longish, length, from eyes, 277 μ; total, 303; width, across eyes, 185; across cheeks, 196; eyes, 100; cheeks behind them, 188; cheeks parallel or very slightly widened posteriorly, surface somewhat roughened; just behind the eyes there is a very small notch, so that the cheeks begin somewhat angularly; postocular bristles black, moderately long, 60 to 68 μ, rounded at tip or blunt, far back, about 52 μ distant from posterior margin of eye; hind ocelli situated at anterior third of eyes, first ocellus somewhat overhanging; mouth cone broadly rounded, labrum blunt; antennæ, length, 484 to 528 μ; measurements of joints: 40 (bristle 44), 60 (36), 84 (32), 84 to 86 (38), 84 to 86 (34), 78 (34), 64 (28), 36 (18) μ; sense cones short, joint 3 with 1, joint 4 with $1 + 2^{+1}$, joints 5 and 6 with $1 + 1^{+1}$, joint 7 with ld; joint 3 with lateral margins straight, 8 short, narrower at base than 7 at apex but not constricted. Fore femora somewhat larger than middle and hind femora but not incrassate; fore tarsi unarmed (in both sexes). Pronotum, width inclusive of coxæ, 372 μ; length, 138 to 147; anteromarginal bristles developed, blunt, length below 40 μ; hind angulars fairly stout, blunt, 100 μ, the inner pair much weaker, 60 μ. Pterothorax width, 398 to 450 μ; wings, length, about 1.03 mm. Ten to thirteen interlocated hairs; basal wing bristles rather pale, 52 to 56, 64 to 68, and 64 to 78 μ in length, all three blunt, their basal plate light. Bristle 1 of those on segment 9 of the abdomen about 224 μ, bristle 2 about 240, hairlike. Tube conical as a whole, somewhat more strongly constricted before apex, and with an indefinite slight concavity in basal third, length, 233 to 250 μ; width across base, 90 to 93; width at apex, 46; anal hairs, about 180.

Male.—There is no striking difference in the sexes; the single male before me has nine double fringe hairs, and bristle 2 of tergite 9 not thornlike, weak, 72 μ. Tip of penis bilobed. Head length, 277 μ; prothorax length, 120.

FORMOSA, Daibu, November 19, 1930, on *Vitis;* Sozan, August 2, 1934, on *Vitis* (*R. Takahashi*).

This species comes in the group of species having tube shorter than head and wings colorless, near *S. kannani* (Moulton), which has, however, middle tibiæ pale in distal half, and legs and antennæ slenderer; all the remaining species have long postocular bristles, except *S. moultoni* (Ram.) ; but this species has tube shorter (170 μ), and antennæ wholly yellow, head longer; *S. tropicus* Schm. has dark antennæ.

HAPLOTHRIPS (ODONTOPLOTHRIPS) DENTIFER sp. nov.

Male.—Dark brown, legs characteristically colored; fore femora brown, apical third pale yellow, middle femora dark, extreme apex paler, hind femora dark at the fore margin, the whole apical third, and the inner (hind) margin yellow-brown, similar to colors in *Neosmerinthothrips;* middle and hind tibiæ wholly dark, fore tibiæ yellowish brown, shaded with gray; joints 1 and 2 of the antennæ somewhat lighter than the head, brown, 2 yellowish apically, exteriorly, 3, 4, and 5 yellow, or 4 and 5 slightly clouded in apical half, 6 pale yellow, always shaded in apical half or third, 7 and 8 dark brown. Wings slightly but distinctly and uniformly shaded throughout their length. Bristles dark.

Head short, length, about 225 μ; including iap, 250; broadest across eyes, 183 to 192; eyes not protruding, their dorsal length (diameter), 95; their lateral length, 87; cheeks slightly rounded and converging posteriorly; surface of vertex somewhat indistinctly netlike; distance of postoculars from eyes, 20 to 24 μ; length, 88 to 96; these bristles nearly pointed or somewhat rounded at tip, which is colorless; mouth cone short, very broadly rounded. Antennæ, length, 450 to 467 μ; measurements of joints: 52 (bristle 46, 36), 60 (32), 76 (30), 72 (36), 60 to 64 (32), 56 to 58 (30), 44 to 50 (24), 34 (15) μ. Joint 1 narrowed towards tip, areola of joint 2 near apex; sense cones acute, joint 3 with 1, joint 4 with $1 + 2^{+1}$, 5 and 6 with $1 + 1^{+1}$, 7 with ld; joint 6 rather broadly truncate at apex, 8 as broad or almost as broad at base as 7 apically. Forelegs (male) strongly enlarged, fore tibiæ with a small tooth apically, fore tarsi with

a large, hooklike tooth, which emerges from a triangular base. Prothorax large, length, about 190 μ; width, 330; including coxæ, 390; median endothoracic thickening strong; bristles on the fore angles very small, external posterolateral bristles about 140 μ; practically pointed, the inner much smaller, 44 μ at the most; coxal bristles long, straight, 88 to 92 μ. Pterothorax width, 398 to 415 μ. Wing, length, about 0.95 mm; width in the middle, about 88 μ; double fringe, 13 to 15; bristles at base almost acute or pencil-shaped, 48, 76, and 72 μ. Bristles on abdomen pointed, long, bristle 1 on segment 9, 208 μ; bristle 2 (male), about 80, not spinelike; bristle 3, 232; all bristles grayish yellow. Tube, length, about 233 to 242 μ; its width across base, 92 to 96; at tip, 40 to 44; shape conical, tube somewhat thick at base, and constricted near apex; anals short, 140 μ. Segment 9 with scalelike appendix below. Total body length, distended, 2.35 mm.

Female.—Similar to the male in every respect, but prothorax smaller, its length, 155 μ; forelegs much less enlarged, fore tibiæ unarmed, fore tarsi with tooth much smaller. Head, 208: 190 μ. Tube as in the male, 234 μ.

LOOCHOO ISLANDS, Amami-Oshima, July 28, 1932, on *Ardisia* (*S. Minowa*).

This species is near *H. hadrocerus* (Karny), but areola of joint 2 is near the tip, while in *hadrocerus* it is in the middle of the joint; antennæ longer, tooth on the tibiæ developed only in the male. *Haplothrips dentatus* Priesner has three sense cones on joint 3 and four on joint 4 of the antennæ; *H. calcaratus* (Hood) is colored differently; the antennæ, especially, are much darker, with joint 3 pale only in basal half; head with lateral tubercles behind eyes; besides, the insect is apterous.

HAPLOTHRIPS CHINENSIS Priesner var. MONTIVAGUS var. nov.

Female.—Black, middle and hind legs black, including tarsi, fore femora, outer and inner margin of fore tibiæ black, the remainder grayish yellow; antennal joints 1, 2, 6, 7, and 8 dark, 3 clear yellow, 4 yellow but slightly clouded in distal half, 5 grayish yellow, shaded in apical half, 6 sometimes paler at base. Bristles dark, those on abdomen yellowish gray to gray. Wings clear, except for a faint shade about the median third.

Head normal, length from eyes, 225 μ; total length, 242; width across cheeks, 200; somewhat narrower across eyes, 194; cheeks gently converging posteriorly; eyes, length laterally, 84 to 86 μ; postocular bristles blunt, rather short, 48 μ, about 16 μ distant

from hind margin of eyes; mouth cone short, rounded; antennæ, 372 to 389 μ; measurements of joints: 36 (bristle 40, t. 30), 52 to 56 (32), 60 (28), 64 to 66 (37), 56 (32), 50 (26), 48 (22), 32 (13) μ; joint 1 strongly converging towards apex, 3 asymmetrical, slender, outer surface seen from above nearly concave, with 1 sense cone; 4 with $2 + 2^{+1}$ sense cones, 5 and 6 each with $1 + 1^{+1}$; bristles on prothorax blunt or open, those on fore angles quite well developed, the posteroangulars somewhat over 80 μ in length, about as in *H. gowdeyi* Frkl.; prothorax, length, 155 μ; width, including coxæ, 320; fore tarsi with a small tooth; pterothorax, 346 to 380 μ (in small specimens only about 311 μ); wings normally constricted, moderately broad, with basal bristles (56 to 64 μ) grayish, open,[2] fringe not pinnate, double fringe 8 to 11; bristles on segment 9 of the abdomen, bristle 1, 105, bristle 2, 128, weak, pointed; tube short, 0.73 the length of head; length, 160 to 168 μ; basal width, 72 to 76 μ; apical width, 38 μ; anal bristles, 184 to 232 μ.

FORMOSA, Mount Ari, April 24, 1931 (*S. Minowa*); Marikowan, August 11, 1934, on *Polygonum* (*R. Takahashi*).

I hesitate to describe this form as specifically different from *H. chinensis* Priesner; the latter has joint 3 of the antennæ almost evenly conical, postoculars longer, wings colorless, antennæ much paler, even joint 6 yellow (shaded apically); but it may be possible that these differences have a biological basis; moreover, *H. fumipennis* Priesner belongs to the same group, and all these will have to be studied closely when more material is available.

HAPLOTHRIPS ALLII sp. nov.

Female.—Gray-brown, tube darkest, body with rich crimson mesodermal pigmentation, turning into orange on metathorax; fore tibiæ pale yellow, shaded only at base, middle and hind tibiæ gray, pale yellow only in apical third; tarsi pale yellow; antennal joints 1, 2, and 8 dark, 3 to 7 pale yellow, 7 may be somewhat shaded. Bristles hyaline to pale gray, wings colorless.

Head longish, length, 208 μ; total length, 225; width across eyes, about 156; across cheeks, 182 (but somewhat diverging posteriorly because of being somewhat pressed); lateral length of eyes, about 70; cheeks behind them, 156; postoculars, which

[2] In the specimens from *Polygonum*, bristle 3 of the base of the wings is hairlike, pointed, about 100 μ in length; bristle 1 on segment 9 of the abdomen, 76 μ.

are dark in mature specimens, moderately long, 40 μ, knobbed, about 16 μ distant from hind margin of eyes; mouth cone rounded; measurements of antennal joints: 24 to 28, 48 to 52, 54 to 56 (27), 64 to 68 (28), 56 to 60 (25), 50 to 52 (24), 46 to 48 (22), 30 to 32 (12) μ; joint 8 distinctly narrower at base than 7 at apex but not constricted, joint 3 with 1 sense cone, joint 4 with 2 + 2; joint 3 slightly asymmetrical; pronotal bristles knobbed, the anteroangulars moderate, 24 μ; posteroangulars, 48 to 52; the inner, 44. Mesothorax, width, 260 to 295 μ; wings rather narrow, fringe not pinnate, no duplicated cilia; basal bristles of forewings knobbed, almost funnel-shaped, 28, 32, and 48 μ in length. Three pairs of colorless bristles on segment 9 of the abdomen, knobbed, bristles 1, 2, and 3, 88 to 92 μ; tube short, conical, length, 116 to 124 μ; width, across base, 56 to 58; across apex, 32; anals, 140 to 160. Legs slender, fore tarsi unarmed in the female. Male unknown.

FORMOSA, Sankaiseki, November 11, 1932, on onion (*Kay Sakimura*).

This species is nearest to *H. apicalis* Bagnall, but the head is much narrower, tibiæ yellow at apical third, legs slenderer, no tarsal tooth, and wings narrow. The appearance is rather that of an *Adraneothrips*.

NEOSMERINTHOTHRIPS FORMOSENSIS sp. nov.

Female.—Blackish brown to black, head paler, light brown, all femora brownish yellow, dark only at outer margins, fore tibiæ yellowish brown, shaded at margins, middle tibiæ more deeply colored, hind tibiæ dark; tarsi yellowish gray. Joints 1 and 2 of the antennæ palest, pale brownish yellow, 3, 4, and 5 with a diffuse tint of gray, 5 darkest, 6, 7, and 8 blackish brown, 6 somewhat lighter than the following. Bristles dark, also those on segment 9, the anals somewhat paler.

Head short and broad, broader than long, length from eyes, 173 μ; including interantennal projection, 200; width across eyes, 200; eyes, length laterally, 72 μ, the posterior ommata larger than the others, hind margin of eyes oblique, and therefore the inner margin of eyes obtuse-angular; distance of eyes, 100 to 105 μ; interantennal distance large, 28 μ; ocelli small, forming a very low triangle; interocellar bristles, 44 μ, pointed, 65 μ distant from each other; postoculars well developed, sharp, almost attached to hind margin of eyes, 68 μ; a few much smaller pairs on vertex and cheeks; the latter are distinctly rounded and converge posteriorly; mouth cone large, rounded at tip, la-

brum blunt, maxillary palpi, 32 (11) μ. Antennæ, length, 390 μ; measurements of joints: 32 to 36 (bristles 42, t. 30), 60 (35), 68 (32), 64 (32), 64 (32), 54 to 56 (28), 42 (24), 30 to 32 (13) μ; joint 1 converging towards tip, areola of joint 2 near apex, joint 3 transversely striated in basal half, with 2 slender, pointed sense cones, joint 4 with 2 + 2, 5 and 6 with $1 + 1^{+1}$ each; joint 6 with conspicuous basal stalk, 7 as well but stalk broad, 8 a little narrower at base than 7 at apex, conical, not constricted at base. Pronotum, length, 138 μ; width, 277; including coxæ, 295; bristles sharp, those on fore angles somewhat over 44 μ; inner anteromarginals, 32; posteroangulars, 68 to 72; inner posteromarginals, 48 to 52. Forelegs simple, fore tarsi unarmed in the female (male unknown). Pterothorax, width, 329 to 363 μ; wings present but not visible in the unique preparation (2 specimens), certainly not constricted in the middle, and moderately long; abdomen much broader than the thorax, bristles rather stout and towards apex of abdomen, dark, moderately long, those on segments 7 and 8, 116 and 95 μ; on segment 9, bristle 2, 104 to 108 μ; bristle 3 longer, over 120 μ; tube short and thick, sides convex in basal third, length, 148 to 160 μ; width at base, 88; across tip, 40 to 42; anals short, not more than 100 μ. Total body length, distended, 1.87 mm.

HOOKOTOO (island near Formosa), Makoo, June 5, 1930 (*S. Minowa*) (? beating).

It should be mentioned here that the typical *formosensis* has prothorax somewhat longer but tube shorter than have the specimens of *formosensis* var. *karnyi* var. nov. from Java, Tjibodas, 400 meters, 1923 (*Karny*), No. 32; Tjibodas, 1,400 meters, 1923 (*Fulmek*), No. 97, in which the tube has a length of 192 to 200 μ; width, 88 to 90 μ; and the prothorax is 120 to 130 μ, including coxæ, 303 μ; the wings of the Javanese form are infumated for their whole length, about 865 μ; their width is moderate, about 68 μ in the middle; double fringe, 8.

The genus *Neosmerinthothrips* Schmutz, generic type *N. fructuum* Schmutz, belongs to the Compsothripini and comes nearest to *Bolothrips* Priesner; it is characterized as follows:

Head short, strongly converging posteriorly; fore femora enlarged, at least in the male sex; fore tarsi with heavy tooth in the male, sometimes without teeth in the female; tube thick, broad at base, in some cases set with very small wartlets at sides; wings parallel-sided; eyes truncate behind, sometimes obliquely; bristles always pointed; in all species the femora are, except on outer margin, inclined to be paler than the tibiæ.

Habitus partly as in *Bolothrips*, partly as in *Eothrips*, but closely related only to the former genus. The following forms of this genus are known to me.

Key to the species of Neosmerinthothrips Schmutz.

1(4). Tube very thick at base, 1.6 to 1.7 times as long as broad, and at base (at least) 2.5 to 3 times (mostly 3.1 to 3.2) as broad as at apex.

2(3). Head larger and thicker, pronotum shorter; antennæ longer, third joint 72.30 μ; eyes broader than long, obliquely truncate behind. *N. fructuum* Schmutz.[3]

3(2). Head smaller, prothorax longer; antennæ shorter, third joint 60.30 μ; fore tarsi armed in both sexes; tube width across base (apex), in female, 112 to 116 (36) μ; in the male, 96 (32). *N. xylebori* sp. nov.

(Tegallega, near Tjibadak, West Java, 500 to 600 meters altitude, March 30, 1925, in channels of *Xyleborus coffeæ*, on coca (*Menzel*).

4(1). Tube at base 2.2 times (at the most) as broad as at apex, 1.9 to 2.3 times as long as broad at base; antennæ about as in *fructuum* but eyes somewhat longer than broad.

5(6). Tube, 192 to 208 (88 to 90) μ; pronotum, 120 to 130. *N. formosensis* var. *karnyi* var. nov.

6(5). Tube, 148 to 160 (88) μ; pronotum, 138........ *N. formosensis* sp. nov.

RHÆBOTHRIPS LATIVENTRIS Karny.

KARNY, Supplementa Entom. (1913) 129; Soc. Ent. Cech. **17** (1920) 42; Ark. f. Zool. **17A** 2 (1924) 29, 50, pl. 4, figs. 35, 36.

MOULTON, Annot. Zool. Japon. **11** 4 (1928) 337.

A series of this species (macropterous female, brachypterous male and female, and larvæ) was collected by H. Uchiyama, August 26, 1933, at Koronya, Ponape (Caroline Islands), on *Cassia occidentalis;* 1 macropterous male, Taihoku, Formosa, July 15, 1912, on *Gossypium* (*M. Maki*); 1 brachypterous male and 1 pupa, Tegallega, near Tjibadak, West Java, 500 to 600 m, March 18, 1925, in channels of *Xyleborus coffeæ*, on coca (*Menzel*); 1 macropterous male, Tjibodas, 1,500 m, August, 1921 (*Karny*), No. 348.

There is no important difference between the specimens from the various localities, but the macropterous males seem to have somewhat shorter antennæ (433 μ) than the brachypterous males (480 to 550 μ).

The female of this species has not been described.

Female.—Agrees with the male in coloration, shape of head and tube, antennæ, etc., but is quite different in the shape of the forelegs, which are normally built; that is, not bent as they

[3] I saw a female of this species in the collection of Dr. Ramakrishna Ayyar, No. 296 B(1).

should be according to the characteristics of the genus; this character, the strongly curved fore femora, is a male character only, and is also found in small males. The tarsal tooth is missing in the female; thus, the female of this genus is built exactly as *Bolothrips* Pr., only the antennæ are somewhat slenderer.

Head, length, 322 μ; including interantennal projection, 363; width across eyes, 225; behind eyes, 234; eyes, laterally, 87; ocelli moderately large, situated before the middle of the eyes; two well-developed interocellar bristles between the hind ocelli; postocular bristles longer than described by Karny, 120 μ and more, and therefore longer than an eye (also in the male). Fore femora, width, 120 μ. Antennæ, joint 3, 132 to 140 μ; joint 4, 124 to 128; joint 5, 104. Prothorax, length, 182 μ; width including coxæ, 415; two pairs of anteroangular bristles conspicuous, posteroangulars long, all pointed, the inner bristles 140 to 148 μ, longer than the outer; wings of the macropterous form with longitudinal streak, and 16 or 17 double fringe hairs; mesothorax 433 to 450 μ in both the macropterous and the brachypterous form. Tube length, 311 to 329 μ; evenly converging posteriorly, width across base, 120 μ; bristles on segment 9 of the abdomen, 242 to 260 μ.

The larvæ are very similar to those of *Bolothrips,* but antennal joint 3 is much longer, 135 to 140 μ, than in any known species of *Bolothrips.*

PLECTROTHRIPS CORTICINUS sp. nov.

Female.—Chestnut-brown, tibiæ somewhat lighter than the femora, yellowish brown; tips of fore femora and tarsi yellowish; bristles yellowish; joint 1 of antenna darkest, as dark as the head, the remainder yellow-brown, 3 a little paler than the others.

Head, length from eyes, 260 μ; total length, 290; width across middle of head (cheeks), 260; eyes varying in length, 78 to 100 μ, laterally; eyes obliquely truncate behind; cheeks evenly convex, their length behind eyes, 147 to 156 μ; hind ocelli far apart from each other, situated at anterior third of eyes at their inner margins, distance of corneæ, 96 μ; just behind the ocelli a pair of small bristles; postoculars long, 112 to 120 μ, pointed (as all the other bristles), situated in the middle of the cheeks, far distant (52 to 56 μ) from hind margin of eyes; surface of vertex smooth; mouth cone very short, as usual in this group, and broadly rounded; antennæ, length, 560 μ; measurements of joints: 40 (bristle 64), 76 (48), 88 (60), 80 (60), 72 (44), 68 (38), 62

(28), 74 (18) μ; joint 1 deeply inserted, sides converging towards apex; 2 with areola somewhat proximal from middle, 3 club-shaped, with 2 large but not very long sense cones which are rounded at tips, 4 with 1 + 2 sense cones, 5 and 6 with 1 + 1, 7 with 1 (lateral); joint 8 long, spindle-shaped. Chitinous central dorsal plate of pronotum 260 μ in length, width, 345; pronotum width, 398 (including coxæ 528); coxæ, as usual, very large, forelegs strongly enlarged, fore tibiæ without teeth, fore tarsi with sharp, curved tooth. Bristles around the central plate of the pronotum vestigial, those on hind angles long, 144 to 160 μ, hairlike; mesothorax width, 450 to 520 μ; wings reduced to small pads, invisible in the preparation; middle and hind legs, as usual, with two stout spurs; bristles on abdomen long, hairlike, bristle 1 on segment 9, over 240 μ; tube length, 264 μ; shape conical, abruptly constricted at apex, width, at base, 112 μ; at tip, 48; terminal hairs, about 240. Total body length, much distended, 2.7 to 3 mm.

Among the species with unarmed fore tibiæ, *P. corticinus* is distinguished from *P. atactus* Hood and *P. pallipes* Hood by the stouter body, and comes nearest to *P. collaris* Bagnall and *P. uncilumbis* (Karny); in *P. collaris* the prothorax is little broader than long and somewhat longer than the head; in *P. uncilumbis* the antennæ are entirely dark, and antennal joint 3 is somewhat shorter than 4.

FORMOSA, Taihoku, April 3, 1928, under bark of a decayed tree (*R. Takahashi*).

ELAPHROTHRIPS TAKAHASHII sp. nov.

Female.—Black, tarsi dark grayish brown, fore tibiæ (as the others) entirely black; spines at cheeks slightly shaded, posteroangular bristles of pronotum colorless, the remaining bristles of the body more or less shaded, those on segment 9 more faintly shaded; wings clear; antennal joints 1, 2, 7, and 8 uniformly blackish brown, 3 to 6 partly pale yellow, as follows: Joint 3 yellow with but end of club dark, 4 with club (apical two-fifths) dark, 5 with about apical half (or more), and 6 with apical two-thirds dark.

Head, length, from eyes, 614 μ; total, 744; width, across eyes, 260; behind eyes, 294; head projection long, as long as broad (136 : 136), very slightly widened anteriorly, front ocellus situated about in its middle, bordered by a pair of long, dark bristles; eyes, length laterally, 147 to 156 μ, outer margin of eyes parallel for about half of their lengths; three pairs of spines,

more or less faintly shaded, moderately stout, length of first, 44 to 48 μ; of third, 48 to 52; between them a few small spines; cheeks constricted behind the eyes, widened posteriorly, so that the head is wider behind than across eyes; there are two pairs of small postocular bristles, length, 60 to 65 μ; first pair 80 to 116 μ distant from eyes, thus placed irregularly; antennæ as usual in this genus, joint 3 with 2 long, hairlike sense cones, joint 4 with $2+2$, 5 with $1+1^{+1}$, 6 with $1+0^{+1}$, 7 with ld; stalk of joints 3 to 5 slender, joint 8 somewhat constricted at base; measurements of joints: 60 (bristle 60, t. 48), 80 to 88 (48), 256 to 260 (bristle 26 to 28, t. 44), 222 to 224 (52), 174 to 180 (44), 132 to 144 (36), 86 to 92 (28), 80 (18) μ. Prothorax, length, 250 to 260 μ; width without coxæ, 415 to 433; fore angular and lateral bristles well developed, rounded at tips, length, about 72 to 80 μ; the inner anteromarginal smaller, 40 at most; posteroangulars, about 132, pale; as in other species, there is a small, lateral, toothlike prominence about the middle of the sides of the prothorax; coxal bristles about 76 μ; fore femora with $2+1$ pale bristles at outer margin; fore tarsi unarmed (female). Pterothorax, width, 623 to 640 μ; wings, length, 2.9 mm, no dark streak indicated, 41 to 43 hairs duplicated; bristle 2 of abdominal segment 9, 450 μ. Tube, length, 588 to 606 μ; width at base, 138 (?); at apex, 69; tube slightly converging posteriorly, more strongly about the apical fourth; length of apical hairs, 345 μ. Male unknown.

LOOCHOO, Amami Ooshima, Gusuku, July 21, 1932 (*S. Minowa*).

This species, belonging to the group of forms having a long anteocular head projection—it is as long as broad in our species—has decidedly pale yellow base of antennal joints 4 to 6 and, therefore, comes close to *E. amœnus* Priesner and *E. fulmeki* Priesner; in *fulmeki*, however, the club of joints 3 and 4 is but indistinctly separated from the basal portion of the joint; therefore, the stalk is thicker, and this species is certainly not identical with the new one; *E. amœnus* has blackish spines on cheeks and fore femora, wings narrower, even somewhat narrowed in the middle, eyes convex, and only 25 fringe hairs duplicated.

LEEUWENIA PUGNATRIX sp. nov.

Female.—Blackish brown; the following parts pale yellow: All tarsi, fore tibiæ (except the extreme base which is faintly shaded at margins), distal half (or more) of the middle and

hind tibiæ, the antennæ from joint 3; joint 8, perhaps sometimes also apex of joint 7, faintly shaded. Wings clear or slightly yellowish.

Head, length, 311 μ; including interantennal projection, 337; width, across eyes, 190; behind eyes, 208 (216 μ in the type specimen, which has head somewhat pressed by the cover glass); a notch behind the eyes; lateral length of eyes, 100 to 105 μ; head surface somewhat rough, but distinctly netlike, sculptured only in front, near the eyes; postocular bristles very small, tender, length, not over 24 μ; hind ocelli situated before the middle of eyes; head indistinctly narrowed anteriorly, cheeks almost parallel; mouth cone short, broadly rounded, reaching only half across the prosternum. Antennæ, length, about 536 μ; slender; joint 1 nearly parallel-sided, 2 with four bristles around the areola, 3 slender, 4 less slender, and somewhat longer than 3, joint 8 not constricted at base, sense cones very thin and long, hairlike, reaching or surpassing the middle of the following joint, 1 cone on joint 3, 3 on joint 4, 2 + 1 (accessory) on joints 5 and 6, and 1 (dorsally) on joint 7; measurements of joints: 40 to 44 (42), 56 (32), 92 (28), 98 to 100 (34), 92 (34), 80 (34), 54 to 56 (24), 44 (14) μ. Pronotum short, length, 160 to 174 μ; width, 330; including coxæ, 380; surface with wrinkles emanating from median line, partly netlike; fore angle bristles yellow, blunt, length, 32 to 36 μ; the outer hind angle bristle of the same shape but longer, 92 to 100 μ, and situated on a little hump; no conspicuous bristles on coxæ; forelegs somewhat reticulate or at least rugose, tarsi simple. Pterothorax, somewhat pressed, 476 μ wide; basal wing bristles short, inserted in a straight line, bristles 1 and 2, 24 to 32 μ; bristle 3, 40, yellow, blunt. Duplicated cilia wanting. Mesonotum finely and densely transversely striated, metanotum longitudinally striated basally, reticulated behind. The triangular basal plate of the first abdominal tergite reticulated; abdomen broadest at segment 2, 450 μ; length, 138; segment 5, width, 346 to 363 μ; length, 173; segment 7, width, 303 μ; length, 182; segment 8, width, 286 μ; length, 156; segment 9, width, 199 μ; length, 138; the latter strongly converging posteriorly; abdomen with thick, blunt, yellow bristles at the sides, which are somewhat shaded on segment 9, their length about 80 μ on segment 6, 70 μ on segment 9; tube very slender, length, 1.21 mm; basal width, 95 μ; apical width, 50 μ; about 13 times as long as broad at base; hairs at the sides of the tube tender, commencing not far from base, and terminating rather far from apex of tube, the

longest (52 μ) are about half as long as the width of the tube across middle, and these hairs are inserted at an angle of about 30° to 35°. Anal bristles, 190 to 208 μ; total body length, much distended, 3.67 mm.

FORMOSA, Hori, September, 1928, 1 female, on *Lithocarpus* (*R. Takahashi*).

This species belongs to the subgenus *Leeuwenia* sen. str., and is distinguished from *L. eugeniæ* Bagnall by the shape of the head, the shorter tube, and the much lighter coloration of the legs; from *L. coriacea* Bagnall by the color of the legs and by the conspicuous anterior lateral bristles of the pronotum; from *L. seriatrix* Karny by the shorter hairs of the tube, the less strongly transverse abdominal segments, and the shape of the head; from the remaining species it is easily separated by the much shorter tube hairs. From species of *Hoodiella* it is quite different by the much shorter head and tube.

292920——6

ACRIDIIDÆ AND TETTIGONIIDÆ FROM LUZON PHILIPPINE ISLANDS

By G. Bey-Bienko

Of the Institute of Plant Protection, Leningrad

ELEVEN TEXT FIGURES

The present contribution is based on a collection of Orthoptera made by Mr. N. Ikonnikov, the well-known Russian authority in Palæarctic Acridiidæ, in the vicinity of Los Baños, Luzon, Philippine Islands, during the period from April 5 to May 25, 1917, and at present deposited in the Zoölogical Museum of Moscow University.

The collection contains forty-three species, of which thirty-three belong to the family Acrididæ and ten to the family Tettigoniidæ; three genera and ten species are new to science, but this number is not unexpected, since the fauna of the Philippine Islands seems to be extremely rich in Orthoptera. During recent years three well-known orthopterists—C. Willemse, M. Hebard, and H. Karny—have made known from this part of the Indo-Malayan Region many new genera and species of Orthoptera.

I wish to express my sincere thanks to Dr. C. Willemse for his advice on some doubtful points, and to Mr. A. Zhelakhovzev, Zoölogical Museum of Moscow University, who kindly submitted this collection to me for study.

The types of all new species are deposited in the Zoölogical Museum of Moscow University.

ACRIDIIDÆ

TETRIGINÆ

Genus CLEOSTRATUS Stål

CLEOSTRATUS MONOCERUS Stål.

Seven specimens. This genus contains only two species known from the Philippine Islands.

Genus HYMENOTES Westwood

HYMENOTES TRIANGULARIS Westwood.

Eleven specimens. Bolivar's *triangularis*, as shown by Kirby,[1] belongs to a quite distinct species named by him *H. bolivari.*

Genus MISYTHUS Stål

MISYTHUS ENSATRIX (Walker).

Two males.

MISYTHUS CRISTICORNIS (Walker).

One male and one female. Both species, known only from Luzon, were fully discussed by Hebard in his recent monograph of the genus *Misythus* (1932).

Genus DIOTARUS Stål

DIOTARUS IKONNIKOVI sp. nov. Text fig. 1.

LUZON, Laguna Province, Los Baños, April 15 to May 25, 1918, 7 males and 11 females (including the type) (*N. Ikonnikov*).

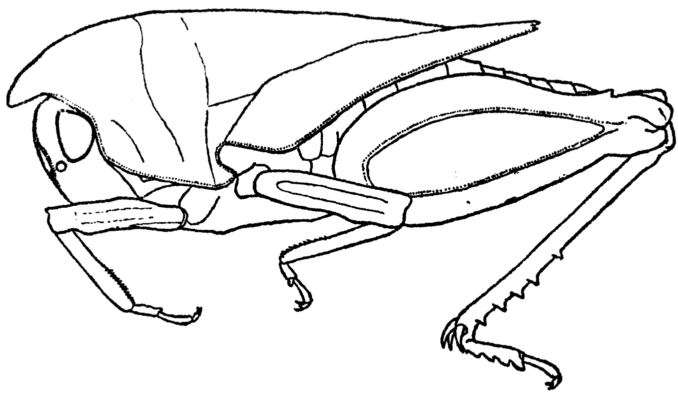

FIG. 1. *Diotarus ikonnikovi* sp. nov., the female type, lateral view; × 6.

Related to *D. pupus* Bolivar but differs strongly in the following features: Body larger; pronotum strongly tectiform in anterior three-fourths, with a sharp median keel; posterior part reaching the apex of abdomen and extending a little beyond the middle part of hind femora, strongly depressed and concave before apical extremity, with median keel gradually disappearing backwards and quite absent in the concave part; anterior half of disc without rugosities, punctured, posterior half with very distinct elevated keel-shaped rugosities some of which are more elevated and placed more or less obliquely to median keel; hind

[1] Catalogue 3: 4.

margin with obtuse angular excision; median keel seen in profile not strongly but regularly bowed in anterior half and practically straight in posterior half. Anterior and middle femora indistinctly undulated, with a feeble preapical lobule on the lower margin; hind femora with distinct and regular oblique wrinkles but without tubercles; hind tibiæ distinctly dilated apically, apex about half again as broad as the middle part of tibia; outer margin with five to seven, inner margin with five or six spines, placed, except for the apical spine, in a third quarter of tibia. Valvæ of the ovipositor long and slender, quite straight, except very slightly incurved apices.

Coloration variable, from light brownish to blackish brown, without black longitudinal stripes on the disc of pronotum, rarely with indistinct dark obliquely placed spots on the middle part of disc; lower outer surface of hind femora darkened; hind tibiæ blackish brown, with two very distinct light rings, one of which is placed on the apex of basal third and another in the basal part of apical half.

Length of body, male, 8 to 10.5 mm; female, 11.5 to 12.4; pronotum, male, 8.4 to 11.1; female, 10.6 to 12; hind femora, male, 5.7 to 7.1; female, 6.9 to 7.4.

This species may be easily distinguished from *D. pupus* by its larger size, shape of pronotum, and especially by the presence of five or six spines on the outer side of hind tibiæ (in *D. pupus* there are only two or three such spines). This last-mentioned feature is shown to be quite constant in a careful study of a series of eighteen specimens. The species is dedicated to its collector.

Genus EUGAVIALIDIUM Hancock

EUGAVIALIDIUM AURIVILLII (Bolivar).

One male and two females. Known only from the Philippine Islands. The species is very similar in its general habitus and the structure of hind tibiæ and tarsi to slender species of the genus *Scelimena* Serville (*S. producta* Serville and specially *S. india* Hancock) and differs from these species chiefly in the presence of very distinct lobes on anterior and middle femora.

Genus TEFRINDA Bolivar

TEFRINDA PALPATA (Stål).

Thirteen specimens. This genus (with a single species mentioned above) was described from the Philippine Islands. It has not been recorded from other parts of the Indo-Malayan

Region, although it is probably widely distributed in the Malay Archipelago, for some specimens of this genus are known to me from Lombok (in the Zoological Museum of the Academy of Sciences, Leningrad), that belong to a new and closely allied species.

Genus BOLOTETTIX Hancock

BOLOTETTIX PERMINUTUS (Bolivar).

Two males and two females. This species was described by Bolivar (1887) from Bulusan, Luzon, under the name *Criotettix perminutus* and included by Hancock (1907) without actual study of the species in the genus *Bolotettix*. Although the species differs from the genotype (*B. validispinus* Hancock, from Borneo) in the absence of a strong transversely produced spine on the lateral lobes of pronotum and in the presence of feebly developed lateral keels in prozona, it belongs to this genus as characterized by the very narrow vertex, cylindrical character of the anterior part of the pronotum, very small elytra (the latter distinctly narrower in the present species than the width of the middle femora), and the insertion of the antennæ barely below the eyes. Lateral keels in prozona very feeble, but distinct and markedly convergent backwards, as in representatives of the genus *Criotettix* Bolivar (Hebard); the disc of the pronotum bears two distinct, parallel, longitudinal carinæ placed between the humeral angles. The last-mentioned feature has not been described by Bolivar, and there is some doubt that these specimens belong to *B. perminutus;* it is possible that they represent a closely allied species.

BOLOTETTIX LUZONICUS sp. nov. Text fig. 2.

LUZON, Laguna Province, Los Baños, April 15, 1927, 1 male (*N. Ikonnikov*).

Similar in general habitus to *B. perminutus* Bolivar and closely related to it. Size small for the genus, form relatively stout. Eyes prominent, not strongly but distinctly elevated above the level of pronotum; interocular space much narrower than dorsal ocular width, about as broad at the middle as half the width of an eye, distinctly narrowing and a little ascendant anteriorly; vertex with distinct longitudinal keel on anterior half, apex with two, short, elevated, obliquely placed, lateral keels open in front; frontal costa, seen in profile, angulately elevated between antennal bases, upper part quite straight, lower part very obtusely excised a little below middle

ocellus; lateral ocelli placed a little below the middle of eyes. Pronotum truncate anteriorly, subulate posteriorly, not strongly but distinctly extending beyond the apex of hind femora; prozona with very feeble, indistinct, lateral keels, feebly convergent backwards; disc of pronotum depressed, practically flat, with dense and profound puncturation; median keel very low, obliterate before anterior margin of pronotum, feebly inflated but not elevated between transverse sulci; humeral angles obtusely angulate, distinctly carinate; supernumerary carinæ near humeral angles distinct; there are also two short, not strong, longitudinal carinæ on the disc between humeral angles. Lateral lobes with posterior angle strongly produced outward into practically transverse, long, conical spines. Elytra very small, narrow, narrowed apically with acutely rounded apex, the visible part about two and one-half times as long as broad. Wings fully developed, reaching the apex of the pronotal process. Anterior femora cylindrical, rather slender, the margins entire; middle femora somewhat depressed, with subundulate margins; hind femora relatively stout, with very distinct oblique rugosities, pregenicular tooth feeble; hind tibiæ regularly broadened to the apex, about twice as broad at the apex as the narrowest part in basal third; external margin with seven, inner margin with six spines; metatarsus scarcely longer than third tarsal joint; all three pulvilli subequal in length, acute but not pointed on the apex.

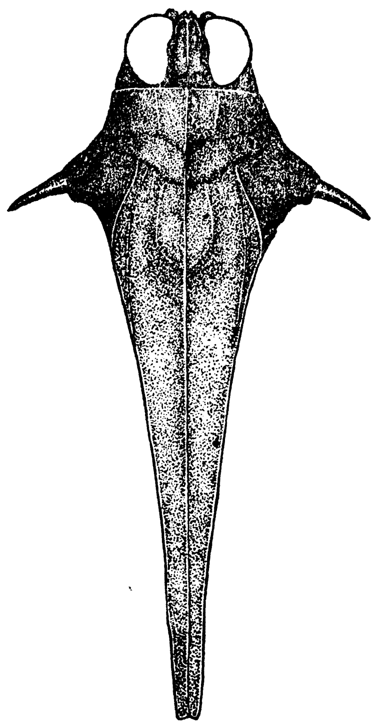

FIG. 2. *Boletettix luzonicus* sp. nov., head and pronotum of the type, dorsal view; × 10.

Coloration dark grayish brown. Elytra, the visible part of wings, lower outer part of hind femora blackened; anterior and middle legs with black rings; hind tibiæ blackish brown, with indistinct light ring at the base.

Length of body, 6.0 mm; pronotum, 7.8; hind femora, 4.5.

The type is unique.

This species is very distinct from *B. perminutus* in the less convergent lateral keel of the pronotal prozona, the more-dilated apex of the hind tibiæ, and chiefly in the presence of a long and sharp conical spine on the lateral lobes of the pronotum. Bruner [2] listed three new species of the genus *Loxilobus* Hancock and two new species of the genus *Boletettix* (of which four species are from Luzon and three even from Los Baños). These species have not yet been described and it is very probable that *B. luzonicus* sp. nov. is one of them.

Genus EUPARATETTIX Hancock

EUPARATETTIX SIMILIS Hancock?

Seven males and six females. This species was described by its author [3] from Borneo and the Philippines, but in the latter case without indication of an exact locality. The precise determination is very difficult without a comparison with typical series, although the description agrees well with the specimens in all principal features.

Genus PARATETTIX Bolivar

PARATETTIX (?) PALPATUS sp. nov. Text fig. 3.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 male; May 22, 1917, 1 male and 1 female (type) (*N. Ikonnikov*).

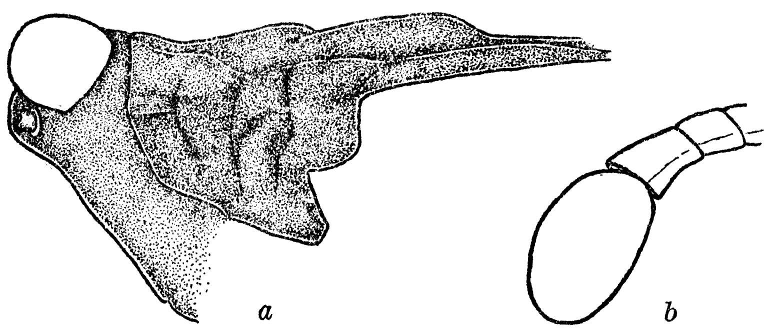

FIG. 3. *Paratettix* (?) *palpatus* sp. nov., a, head and pronotum of the type, lateral view; × 6; *b*, maxillary palpus, greatly enlarged.

Body elongated, slender. Eyes widely separated, globose, upper surface somewhat elevated above the level of vertex; vertex as broad as an eye, distinctly narrowed anteriorly, with a feeble longitudinal keel and two lateral, lobiform and obliquely placed

[2] Univ. Studies Lincoln 15 (1915) 244 and 249.
[3] Trans. Ent. Soc. London (1907) 238.

keels, which are distinctly convergent anteriorly; hind part of vertex with a small but distinct transverse keel-shaped elevation placed in the posterior quarter of interocular space. Frontal costa seen in profile strongly compressed-elevated between antennal bases; upper part between eyes quite vertical, obscured by eyes and not visible laterally, lower part distinctly obtusely excised at median ocellus; paired ocelli placed a little below the middle part of eyes. A line joining the ventral margins of eyes passes a little above the antennal base; antennæ very slender, twice as long as the anterior femora with very elongated joints. Maxillary palpi with apical joint depressed and dilated, half again as broad as the preceding joint.

Pronotum strongly elongated, truncate anteriorly, posteriorly subulate, reaching the apex of hind tibiæ; lateral keels in prozona not strong but distinct, feebly convergent backward; humeral angle keeled, supernumerary keels distinct, straight, reaching the posterior sulcus; transverse sulci very deep on the disc and lateral lobes; median keel distinct on its whole length, low, somewhat inflated between transverse sulci but not elevated; the disc flattened, densely and strongly punctured, interhumeral part on the middle somewhat elevated along the median keel and bordered with very distinct lateral longitudinal keels; interspace between these and median keel equal to the interspace between supernumerary and the same keels; posthumeral part of the disc, just behind apices of the longitudinal keels, distinctly depressed, with sparse, irregular, longitudinal callosities. Lateral lobes with posterior angle subvertical, roundly truncate at the apex; elytral and inferior sinuses rectangular.

Elytra relatively narrow, about three times as long as broad, apex not broadly rounded.

Anterior and middle femora very long, slender, carinæ entire; hind femora slender, with very distinct callous oblique elevations; posterior tibiæ scarcely dilated toward the apex, with six to eight outer, and five to seven inner spines, minutely serrulate between them; hind metatarsus equal in length to third joint.

Valvæ of the ovipositor long, slender, straight, strongly spinose.

Coloration dark grayish brown. Elytra with blackened lower margin; the visible part of wings black. Anterior and middle legs unicolorous, hind femora with lower outer part blackened; hind tibiæ blackish brown, with very indistinct light ring at the base.

Male.—Like the female, but smaller.

Length of body, male, 7.5 mm; female, 9; pronotum, male, 12 to 12.2; female, 14.2; hind femora, male, 4.8 to 5; female, 5.7.

The generic determination of this interesting species is somewhat doubtful as it is characterized by very peculiar structure of the head and maxillary palpi; in some respects it resembles the genus *Xistra* Bolivar, but the structure of the posterior angle of pronotum is typical for the group Acridiini. In all probability it represents an undescribed genus, but I hesitate to describe it as the group is in a state of confusion and a detailed revision of all genera is strongly necessary.

Bruner [4] recorded "*Platypalus* sp." from the Philippines; probably this is a misprint for "Platypalpus" (this genus was never described in Tetriginæ) and it is very probable that Bruner has had the same species.

PARATETTIX PLATYNOTUS sp. nov. Text fig. 4.

LUZON, Laguna Province, Los Baños, April 5, 1917, 1 female (type) and 1 male (*N. Ikonnikov*).

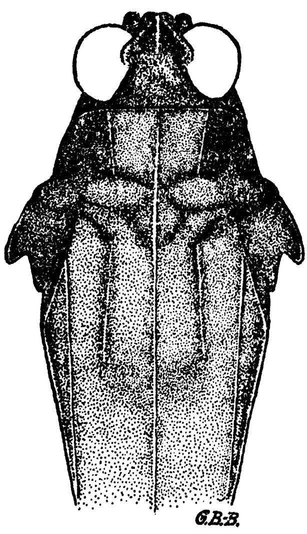

FIG. 4. *Paratettix platynotus* sp. nov., head and pronotum of the type, dorsal view; × 6.

Slender, elongated, size medium for the genus. Eyes scarcely elevated above the level of pronotum; vertex not ascendant forward, broad, slightly broader at the middle than an eye, somewhat narrowed anteriorly, median keel feeble but distinct, lateral keels in anterior part obliquely placed, convergent backward, forming with median keel a sharpened angle; frontal costa roundly produced between antennal bases, the supra-antennal part seen in profile not vertical, somewhat sloping, forming with vertex a rounded angle which is obscured by the eyes; the fork narrower than antennal socket; paired ocelli placed between the median points of eyes. Antennæ very thin (long ?); lower margin of antennal bases placed a little below lower margins of eyes.

[4] Op. cit. 249.

Pronotum strongly deplanate; the disc practically flat, finely tuberculate, with indistinct callosities; prozona somewhat broader than long, lateral keels very thin, feebly convergent backward; median keel very fine, not elevated, except the interval between the transverse sulci where it is very feebly inflated and indistinctly raised; anterior part of metazona from the hind transverse sulci with two very distinct, linear, straight carinæ, reaching a little beyond line connecting humeral angles; the latter distinctly keeled, obtusely angulate; supernumerary keels well developed, straight, beginning somewhat before shoulder angles; apical process reaching the apex of hind tibiæ, slender. Posterior angles of lateral lobes not reflexed outward, forming a sharpened and narrowly rounded angle.

Elytra oval; wings fully developed, reaching the apex of pronotal process.

Anterior and middle femora very slender, long, parallel-sided, about five times as long as broad, carinæ entire. Hind femora slender; hind metatarsus equal in length to third tarsal joint, the three pulvilli of the metatarsus equal in length, rectangular.

Coloration uniformly grayish brown.

Length of body, male, 6.7 mm; female, 9.3; pronotum, male, 11.6; female, 12.7; hind femora, male, 4.9; female, 5.3.

This well-characterized species shows distinct affinity to the Bornean *P. angulobus* Hancock [5] in the depressed pronotum bearing two abbreviated carinæ between humeral angles, in the quite similar structure of hind tarsi, and in some other features; but the new species is well separated from *P. angulobus* by the broader vertex, strongly narrowed anteriorly; by the distinctly bicarinate shoulders, not reflexed outward; by the posterior angle of the lateral lobes; and by some less-important features.

PARATETTIX sp. nov.?

Two males. An extremely graceful species; densely pilose lower surface of body very narrow; long pronotum with median keel sharpened and, seen in profile, practically straight, with spiculate pulvilli on hind tarsus. Probably a new species, but I hesitate to describe it without a comparison with others belonging to the same group of this genus.

[5] Trans. Ent. Soc. London (1907) 236.

Genus HEDOTETTIX Bolivar

HEDOTETTIX GUIBELONDOI Bolivar?

Four males and six females. In its general habitus, structure of pronotum and head, this species resembles strongly *H. gracilis* De Haan, but differs from the latter in the less-elevated median keel of pronotum and in the longer third pulvillus of the hind metatarsus; in this respect it agrees with *H. guibelondoi* Bolivar, described from the Philippines (Sibul), on the female sex alone and then recorded by Bruner [6] from Los Baños. The male sex, as in *H. gracilis,* is characterized by short and broad median femora.

HEDOTETTIX sp.?

One male. The exact determination of this single specimen is impossible without a comparison with other members of the genus.

EUMASTACINÆ

Genus MNESICLES Stål

MNESICLES sp. (aff. FURCATUS Saussure).

One female. This is probably a new species; it resembles *M. furcatus* Saussure, from New Guinea, in the structure of the subgenital plate.

I hesitate to describe a new species on a single female specimen without comparison with true *M. furcatus.*

MNESICLES CRASSIPES Karsch?

Two females. The female sex of *M. crassipes* is unknown and therefore an exact determination of these specimens is impossible. In C. Bolivar's key of the species of the genus *Mnesicles* [7] it runs to *M. novæguineæ* Bolivar, but according to Doctor Willemse, who studied one female specimen, it is certainly not identical with this species.

Female.—Fastigium of the vertex distinctly produced, subparallel, about twice as long as the interocular space, seen in profile distinctly projecting before dorsoanterior margin of eye, upper surface very feebly sloping backward, practically horizontal; face somewhat rugged but without distinct rugosities. Pronotum with truncate anterior margin and roundly triangular hind margin, prozona subcylindrical, equal in length to metazona; seen in profile the dorsal surface of the pronotum is

[6] Op. cit. 249.

[7] Bol. Soc. Esp. Hist. Nat. 31 (1931) 292.

distinctly concave; median keel well developed, especially in metazona, interrupted between transverse sulci. Elytra narrow, practically parallel-sided, with very feebly dilated apical extremity, reaching the base of the genicular part of hind femora. Anterior femora broad, without conical projection in the basal part; hind femora thick, about three times as broad as the elytra; dorsomedian and dorsoexternal keels with relatively sparse denticulation; three lower keels unarmed. Hind tibiæ distinctly sinuated, with twenty-one or twenty-two spines on the outer, and fifteen spines on the inner side. Subgenital plate with profound, narrowly triangular excision on hind margin and narrowly rounded lobes.

General coloration brownish gray, with dark and pale spots. Face dirty pale, with brownish gray spots; antennæ grayish in basal half and blackened in apical half. Elytra brownish gray with a narrow preapical pale band; wings infumated. Hind femora with blackish brown fasciæ and spots; hind tibiæ blackish brown, with pale fasciæ and spots.

Length of body, 22 mm; pronotum, 3.9; elytra, 12.3; hind femora, 12.7.

Genus ERIANTHUS Stål

ERIANTHUS ERECTUS Karsch.

Thirteen males and seven females. Doctor Willemse has kindly compared my specimens with typical *E. erectus* determined by C. Bolivar.

ACRIDIINÆ

Genus AIOLOPUS Fieber

AIOLOPUS TAMULUS (Fabricius).

Many specimens. A widely distributed species previously known from the Philippine Islands.

Genus EOSCYLLINA Rehn

Eoscyllina REHN, Bull. Am. Mus. Nat. Hist. 26 (1909) 186–188 (genotype, *Eoscyllina inexpectata* Rehn, from Sumatra).

Bakerella BOLIVAR, Trab. Mus. Nac. Cienc. Nat., Zool. N 20 (1914) 70–71 (genotype, *Bakerella luzonica* Bolivar, from the Philippine Islands) (syn. nov.).

Bolivar did not mention the most peculiar feature of the genus *Bakerella* (the strongly unequal inner calcaria of the hind tibia) and therefore he incorrectly included this genus in the group Ochrilidiæ. The genus is unquestionably a member of

the group Scyllinæ (= Prosthetophymæ Bolivar) as characterized by strongly unequal inner calcaria of the hind tibiæ. Moreover, a careful comparison of the topotypic specimens of Bolivar's *Bakerella luzonica* (fully described by me below) with very good description and figures of Rehn's *Eoscyllina inexpectata* convinced me of the identity of the two genera; both genotypes are extremely similar, practically in all essential features, and show very close affinity. Dr. C. Willemse, who studied my specimens, has advanced the same opinion with regard to the synonymy of these genera.

EOSCYLLINA LUZONICA (Bolivar). Text fig. 5.

Bakerella luzonica BOLIVAR, Trab. Mus. Nac. Cienc. Nat., Zool. N 20 (1914) 71 (♂, ♀; Los Baños, Luzon, Philippine Islands).

LUZON, Laguna Province, Los Baños, April 15 to May 25, 1917, 19 males and 16 females (*N. Ikonnikov*).

Female.—Allied to the type species *E. inexpectata* Rehn, from Sumatra, but differing somewhat in the shorter elytra and in other features. Form elongate, slender. Head with interocular space distinctly narrower than the fastigium and a little broader than the maximum width of the frontal costa; fastigium of vertex rectangular on the apex, somewhat shorter than broad, with very distinct transverse bow-shaped impression, slightly sloping, practically horizontal; foveolæ of vertex well marked, subrectangular, with sharp margins, a little less than twice as long as broad, subvertical and, therefore, not completely visible from above; occiput with a feeble but distinct median carina throughout, reaching anteriorly the middle of the interocular space, and with two very indistinct supplementary carinæ, moderately divergent backward, surface between carinæ with more or less distinct transverse rugosities; face strongly reclinate, slightly convex, forming with the fastigium a rather narrowly rounded angle of about 45°; frontal costa strongly narrowed to the fastigium, scarcely constricted near the middle ocellus and subparallel below it, with a very distinct median carina between middle ocellus and upper margin of the costa; lower part not impressed, with a dense and coarse puncturation; supplementary facial carinæ relatively sharp, very regularly incurved; there

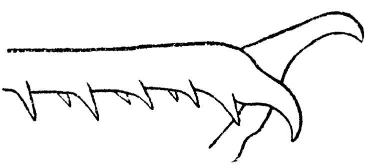

FIG. 5. *Eoscyllina luzonica* Bol., apex of hind tibia of female, greatly enlarged.

is also a pair of irregular and abbreviate carinæ placed below antennal socket along inner side of the supplementary carinæ; eyes acute above, anterior margin almost straight, about two and one-half times as long as the infraocular portion of the genæ; antennæ scarcely longer than the head and pronotum.

Pronotum with lateral keels well developed, practically straight, subparallel in the prozona and more distinctly divergent in the metazona; there are also two less distinct, quite parallel, supplementary, longitudinal carinæ; transverse sulcus a little before the middle of the pronotum; median keel very distinct but low; hind margin obtusely angulate, with the apex rounded, anterior margin subtruncate. Lateral lobes vertical, their vertical depth a little greater than dorsal length, anterior half of the ventral margin obliquely truncate.

Elytra extending beyond the apex of hind femora for a distance equal to half the pronotum, relatively narrow, as broad as the maximum width of hind femora, apex narrowly rounded; intercalary vein in discoidal field irregular but almost completely developed. Wings relatively narrow, subtriangular, apices of two first lobes well separated.

Hind femora reaching well beyond the apex of the abdomen; hind tibiæ with dense and long hairs, distinctly shorter than the femora, inner side with twelve or thirteen, outer side with eleven or twelve spines; internal calcaria distinctly unequal, strongly incurved apically.

Valvæ of the ovipositor relatively short and thick; dorsal surface of the upper pair strongly bowed downwards; lower pair without teeth on the outer margin, but obtusely excised.

Male.—Smaller and much slenderer. Head with very feeble and indistinct longitudinal carinæ on the occiput; additional pair of the suplementary facial carinæ very short and sometimes almost indistinct; fastigium of vertex forming an angle a little less than 90°; antennæ practically half again as long as the head and pronotum.

Supplementary longitudinal carinæ of the pronotum very feeble or indistinct. Elytra with feebly broadened scapular area, which is scarcely broader than discoidal area; scapular area reaching the base of the apical third of elytra; apical third parallel-sided except for a short apical distance; discoidal area with an irregular, sometimes broken and abbreviate false vein.

Hind tibiæ with nine to eleven spines on the outer side and eleven or twelve spines on the inner side.

Subgenital plate densely pilose, relatively short, broadly conical, apex moderately acute; anal plate triangular, a little longer than broad at the base, with a feeble, median, longitudinal impression; cerci narrowly conical, acute at the apex, reaching the apex of the anal plate.

General coloration very variable, from pale yellowish to uniformly coal black, with various intermediate forms. Antennæ black or in pale yellowish specimens with pale brownish basal half of the upper surface and dark brownish lower surface. Elytra unicolorous or with indistinct dark spots, especially in discoidal area. Wings pellucid; apices of the first and second lobes infumate. Hind femora uniformly pale yellow, with blackened upper part of genicular area, or in dark specimens with several small black spots, especially along upper and lower outer keel, or sometimes completely black; hind tibiæ dirty yellowish, reddish brown, or, in the pale yellowish specimens, dirty reddish; spines black-tipped. Abdomen pale yellowish.

Length of body, male, 15.5 to 17.5 mm; female, 20 to 23; pronotum, male, 2.9 to 3.1; female, 3.5 to 4; elytra, male, 15.1 to 16.2; female, 17.3 to 19; hind femora, male, 10.3 to 11.1; female, 11.6 to 13.1.

This interesting species differs from the genotype in somewhat shorter elytra, in the presence of supplementary carinæ on the occiput and pronotum, and in densely pilose hind tibiæ.

I was greatly surprised to see a long series of specimens belonging to the genus *Eoscyllina* previously known from the single female type specimen from Sumatra, and at first I was inclined to describe a new species of this genus; but a detailed comparison of my series with Bolivar's *Bakerella luzonica* showed that my species is identical with the latter.

The group Scyllinæ (= Prosthetophymæ), fully represented in the American fauna, includes but few Indo-Malayan genera and species, and the discovery of an additional species in the Philippine Islands is very interesting.

ŒDIPODINÆ

Genus TRILOPHIDIA Stål

TRILOPHIDIA ANNULATA (Thunberg).

Twelve males. The structure of the pronotum as in typical *annulata*, but specimens differ from this species in somewhat smaller size; therefore, they were determined previously by me

as *T. cristella* Stål, but Doctor Willemse has identified them as *T. annulata*.

The dimensions of the series are as follows: Length of body, male, 12.5 to 15.1 mm; female, 17.2 to 18.5; pronotum, male, 2.9 to 3.4; female, 3.5 to 4; elytra, male, 13.9 to 16.0; female, 16.8 to 18; hind femora, male, 8 to 9.5; female, 9.3 to 10.2.

Genus GASTRIMARGUS Saussure

GASTRIMARGUS MARMORATUS (Thunberg).

Nine males and six females. A widely distributed species. Specimens belong to var. *transversus* Thunberg.

Genus HETEROPTERNIS Stål

HETEROPTERNIS RESPONDENS (Walker).

Ten males and eight females. The coloration in the present series varies from almost coal black to dark yellowish brown.

PYRGOMORPHINÆ

Genus ATRACTOMORPHA Saussure

ATRACTOMORPHA PSITTACINA (De Haan).

Twenty-five males and six females. A widely distributed Indo-Malayan species previously recorded from the Philippine Islands.

CATANTOPINÆ

Genus IKONNIKOVIA novum

A member of the group Euthymiæ; not closely related to *Euthymia* and its nearest allies, but resembling somewhat in the structure of the pronotum the Central American group *Mezentia* Stål.

Body short and thick. Antennæ filiform, long, extending beyond basal part of hind femora. Head very short, not broader than pronotum, face quite vertical, coarsely punctured; frontal ridge seen in profile quite straight, not projecting between antennal bases, without a sulcus, with very coarse puncturation; lateral margins subparallel, except a slightly widened part just below antennal base, subobliterated below and scarcely reaching the lower margin of front; median ocellus feebly, supplementary facial carinæ well marked, strongly divergent downwards, practically straight; fastigium of vertex short, strongly sloping, almost hexagonal, margins obtuse, practically as broad as long, its surface slightly concave, with a distinct transverse impres-

sion; forming with the frontal costa a very obtuse and rounded, practically indistinct angle; interocular space half again as broad as the frontal costa; eyes not strongly prominent sideways, oval, a little more than twice as long as the infraocular distance of genæ.

Pronotum twice as long as the head, subparallel-sided, without any trace of lateral keels and with a very faint indication of a median keel; all three sulci well indicated on the disc and lateral lobes, third sulcus placed in hind part of the posterior third quarter, second sulcus placed in the middle of the pronotum; anterior margin subtruncate; metazona somewhat elevated, with a well-marked but small, roundly obtuse tubercle, projecting backward, but not extending beyond the straight hind margin of the pronotum. Lateral lobes vertical, without a distinct upper border, strongly narrowed downward, with almost straight anterior margin and oblique hind margin, without indication of humeral angles; lower part of lateral lobes roundly triangular. Prosternal tubercle strongly flattened, distinctly widened apically, with the apex truncate. Mesosternal lobes somewhat broader than long, with broadly rounded inner margins, interspace between them slightly broader than long; metasternal lobes not broadly separated.

Elytra and wings strongly abbreviated, the former considerably shorter than pronotum, broader than long, rhomboidal, scarcely touching each other by their inner posterior angles; the surface of elytra covered with dense reticulation of veins, longitudinal veins indistinct; wings of the same length as the elytra, a little projecting in a small lobule above the upper hind angle and behind posterior lower angle of elytra.

Hind femora relatively slender, strongly extending beyond the apex of the abdomen, margins entire, the outer upper and lower area very narrow, knee lobes subrectangular. Hind tibiæ slightly sinuate, with nine spines on both sides, outer apical spine very distinct; hind tarsi practically reaching the middle of hind tibiæ, third joint equal in length to two preceding taken together.

Abdomen with tympanum well developed. Supra-anal plate of female triangular, not longer than broad, without keels or impressions, apex rectangular; cerci of female very short, conical; valvæ of the ovipositor relatively short, upper pair strongly concave above, with roundly incurved and acute apex; lower pair with very narrow, slightly incurved apices, without outer tooth.

The whole surface of the body covered with hairs, which are longer and dense on the hind margin of the pronotum and metazonal tubercle, on elytra, and on hind tibiæ.

Genotype.—*Ikonnikovia philippina* sp. nov.

This peculiar genus is characterized by a number of important features and resembles somewhat in the structure of the pronotum the genus *Mezentia* Stål, which, according to descriptions by Stål (1878) and Hebard (1932), is more or less similar in the structure of the metazona of pronotum, but with a more-developed and elevated tubercle. From a single brachypterous Indo-Malayan member of the group (*Perakia* Ramme) it strongly differs in the structure of the pronotum, the form of the elytra, and many other features.

IKONNIKOVIA PHILIPPINA sp. nov. Text fig. 6.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female (*N. Ikonnikov*).

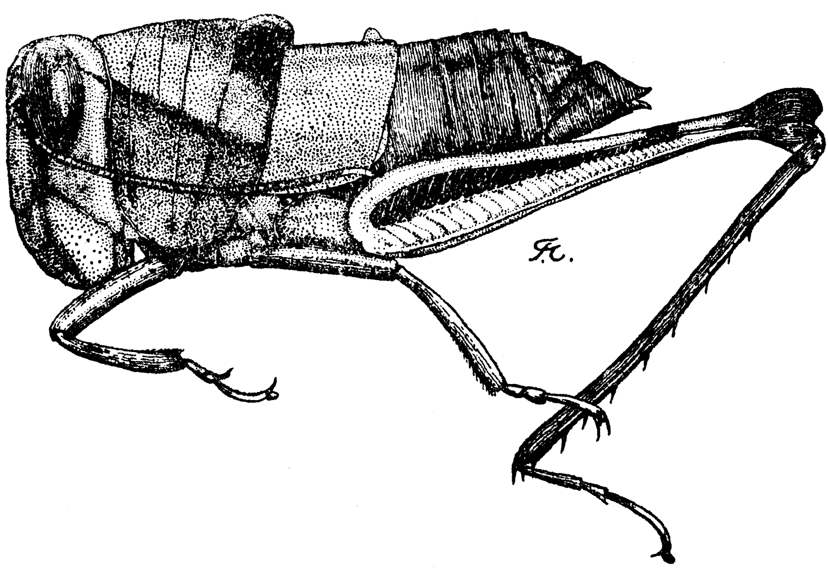

FIG. 6. *Ikonnikovia philippina* gen. et sp. nov., the female type, lateral view; × 4.

Female.—General coloration brownish yellow, with black stripe. Front dark brownish; antennæ blackish except pale yellow basal and four apical joints; occiput with two lateral postocular black stripes and with a short black median stripe just before the pronotum. Pronotum and lateral lobes dirty yellow with a broad, oblique, pale yellow stripe on lateral margins of

the disc, bordered below with very sharp, narrow, and oblique black stripe; disc of the metazona black, except brownish yellow tubercle. Elytra uniformly yellow. Abdomen and thorax uniformly brownish yellow, valvæ of the ovipositor olivaceous. Hind femora yellow, with very sharp black longitudinal stripe narrowed apically but tipped by a black transverse fascia on the upper and inner side of the basal part of the apical third of femora; inner side pale yellow except the above-mentioned black fascia; lower side reddish; knee part reddish brown. Hind tibiæ and tarsi, anterior and middle legs, greenish olivaceous.

Length of body (abdomen somewhat constricted), 19.5 mm; antennæ, 14; pronotum, 5.9; elytra, 3; hind femora, 16.

The type is unique.

Genus OXYA Serville

OXYA INTRICATA Stål.

Many specimens. A widely distributed Indo-Malayan species.

Genus PSEUDOGERUNDA novum

A brachypterous member of the group Oxyæ with hind tibiæ lacking the outer apical spine. Body slender, finely rugose. Antennæ filiform, long in male, extending behind the base of hind femora for a distance subequal to maximum width of the latter, in female somewhat shorter than the head and pronotum together. Head equal in length to pronotum, with strongly reclinate and coarsely punctured face; frontal ridge seen in profile quite straight, not projecting between the antennæ; its keels straight, feebly divergent downwards; sulcus distinct and relatively deep on the whole length of the ridge. Supplementary facial carinæ distinct, sharp, practically straight. Fastigium of vertex not strongly but distinctly sloping, not separated from the frontal ridge by a transverse keel, forming with the frontal ridge an acute but rounded angle, parallel-sided in basal part and widened forwards, anterior margin broadly rounded; the surface somewhat impressed on the middle and with a fine but distinct median carinula in anterior part; occiput feebly convex, somewhat rugose laterally, but without median carinula; interocular space about as broad as the lower part of the frontal ridge; eyes oval, relatively broad, prominent sideways, about two and one-half times as long as the subocular sulcus.

Pronotum cylindrical, finely rugose, without lateral keels; median keel subobsolete, present only in anterior fourth part of the prozona and in the metazona; anterior margin subtruncate; posterior margin triangularly excised in the middle; transverse sulci

fine but distinct; first sulcus developed on the disc only; two other sulci both on the disc and on the lobes; third sulcus placed far behind the middle; lateral lobes longer than high, vertical, the lower margin ascendant from its middle to the anterior angle, which is very obtuse, rounded; posterior angle rounded, obtuse-angulate; posterior margin feebly excised. Prosternal tubercle slender, conical, acute but not pointed on the apex, quite straight. Mesosternal lobes strongly transverse, their interspace very narrow, in male about twice, in female half again as long as broad, metasternal lobes contiguous (male) or subcontiguous (female) in the posterior part.

Elytra rudimentary, lateral, squamiform, very narrow; reaching the posterior margin of the second abdominal tergite, upper (hind) margin straight, lower (anterior) subparallel to the upper, bow-shaped, incurved; apex rounded; wings absent. Tympanum membranaceous.

Anterior and middle femora thickened; hind femora relatively thick in basal part, with very sparse long hairs; all the keels smooth; knee lobes angulate but not pointed on the apex, inner lobe acute, outer lobe nearly rectangular. Hind tibiæ not expanded apically, straight, margins smooth, with seven or eight spines on the outer, and nine or ten on the inner side, densely pilose, especially in the male; outer apical spine absent; hind tarsi somewhat shorter than half the length of hind tibiæ, metatarsus about twice as long as the second joint and subequal in length to the third joint; calcaria between claws large.

Abdomen very slender, especially in the male, with median longitudinal keel, rugosely punctured above; five to seven sternites densely pilose, especially in the female. Supra-anal plate short, transverse, with very distinct, especially in the male, longitudinal sulcus, hind margin truncate (female) or subexcised on the middle (male); subgenital plate in male short, obtusely conical, in female triangular, acute on the apex; cerci narrowly conical, in male considerably, in female a little, longer than supra-anal plate; valvæ of the ovipositor relatively short, thickened in basal part, upper pair roundly excised above, with the apex acute and roundly incurved; lower pair with a strong, rounded excision in apical half and with a narrow and feebly incurved apical part; margins without distinct denticles.

Genotype.—*Pseudogerunda willemsei* sp. nov.

Although this genus is characterized by the absence of the external apical spine of the hind tibiæ, it unquestionably belongs to the group Oxyæ as it has all the features peculiar to this group.

It resembles strongly the genus *Gerunda* Bolivar (known also from the Philippine Islands) in many features and was provisionally determined by me as a member of this genus, but *Gerunda* is characterized by the presence of the external apical spine on the hind femora. Dr. C. Willemse, who studied my specimens, has considered that they belong to a new genus and species. In Bolivar's key[8] the new genus runs to *Gerista* Bolivar but is not closely allied to it.

PSEUDOGERUNDA WILLEMSEI sp. nov. Text fig. 7.

LUZON, Laguna Province, Los Baños, May 15 to 22, 1917, 3 males (including the type) and 1 female (*N. Ikonnikov*).

Male.—Size relatively small for the group. Body densely pilose, especially the lower surface and the legs. General coloration dirty olive-green. Antennæ uniformly blackish brown; face between supplementary lateral carinæ dark marmoraceous, postocular stripe very broad, blackish brown or black, bordered on its lower margin by a narrow pale yellowish stripe reaching the middle of anterior margin of eye; dorsal surface of the head dirty yellowish, sometimes with a dark longitudinal stripe. Disc of pronotum of the same color as the dorsal surface of the head; lateral lobes blackish brown or black, with a relatively broad, pale yellowish, longitudinal stripe a little above the lower margin of lobes. Elytra uniformly blackish brown. Metapleura black, with a pale spot. Abdomen dirty yellowish, with an indistinct dark lateral stripe, apex reddish yellow. Legs olivaceous-green; lower surface of hind femora pale yellow, genicular arch blackened; hind tibiæ dirty red, with somewhat darkened basal half; two basal joints of hind tarsi reddish, apical joint olivaceous.

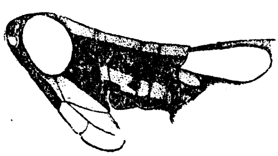

FIG. 7. *Pseudogerunda willemsei* gen. et sp. nov., head, pronotum, and elytra of the type, lateral view; × 7.5.

Female.—Considerably larger and more robust. Coloration as in the male, but lateral longitudinal stripes on the abdomen broader and more distinct.

Length of body, male, 17.2 to 17.6 mm; female, 23.5; pronotum, male, 3.7 to 3.8; female, 4.6; elytra, male, 2.5 to 3; female, 3.8; hind femora, male, 11.2 to 11.8; female, 14.7.

This new species is dedicated to Dr. C. Willemse, the well-known authority on the Indo-Malayan Acridiidæ.

[8] Trab. Mus. Nac. Cienc. Nat., Madrid N 34 (1918) 6–13.

Genus PARRACILIA Willemse

PARRACILIA LUZONICA Willemse.

One female and one larva (female). This genus and this species were described by Willemse from Baguio, Luzon, on a single female specimen. Specimens from Los Baños agree well with the original description;[9] the adult female was also compared by Doctor Willemse with a type of this species.

Genus BINALUACRIS Willemse

BINALUACRIS POLYCHROMA sp. nov. Text fig. 8.

LUZON, Laguna Province, Los Baños, May 15 to 22, 1917, 2 males (*N. Ikonnikov*).

Male.—Size small, body slender. Antennæ reaching the base of hind femora. The structure of the head and pronotum as in the genotype, *B. viridis* Willemse. Elytra lateral, scalelike, scarcely widened to the apex of the second third, rounded on the apex, reaching the base of the second abdominal segment. Abdomen slender, carinate above. Anterior and median femora thickened, about twice as broad as the respective tibiæ, with sparse and short hairs, hind femora long and relatively thick, extending well beyond the apex of abdomen, sparsely pilose, outer genicular lobes rounded, inner lobes practically rectangular; hind tibiæ very feebly S-shaped incurved, practically straight, with dense and long hairs, outer side with seven or eight, inner side with nine spines, outer apical spine absent. External genitalia as in the genotype.

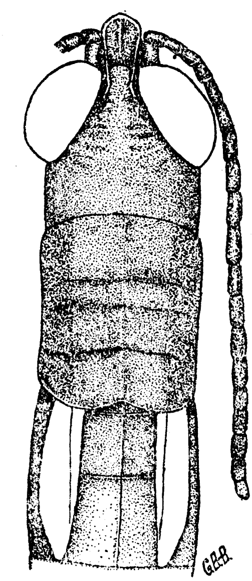

FIG. 8. *Binaluacris polychroma* sp. nov., head, pronotum, and elytra of the type, dorsal view; × 7.5.

General coloration green. Antennæ dark blue except the light blue basal part and whitish apical joint. Head and pronotum uniformly green, without stripes. Basal part of abdomen and elytra of the same color as the head and pronotum, apical part red; cerci brownish black, supra-anal plate red. Sternum and the basal part of abdomen yellowish green. Anterior and median femora olivaceous-green, anterior

[9] Natuurhist. Maandbl. (1933) No. 10.

and median tibiæ bluish. External and inner sides of hind femora orange-red in the basal third, knee part red, the intermediate part green; basal half of the lower sides orange-red, the remaining part bluish green; hind tibiæ dark blue, spines dark blue, with blackish brown tips; tarsi olivaceous-green.

Length of body, 16.9 mm; pronotum, 3.6 to 3.7; elytra, 2.8 to 2.9; hind femora, 10.8.

This handsome species is very similar in its morphological features to the genotype, *B. viridis* Willemse, recently described from Palawan Island. The new species is easily separated from *B. viridis* by its smaller size, shorter antennæ, and very striking coloration, specially of the antennæ, hind femora, and hind tibiæ.

Doctor Willemse has compared the new species with a paratypical specimen of his *B. viridis* and fully agrees with my determination of this insect.

Genus TONISTA Bolivar

TONISTA BICOLOR (De Haan).

Five males. This species was previously known from Japan, Java, Bali, and Sumatra; and, therefore, its occurrence in the Philippine Islands is quite natural.

The specimens agree well with Willemse's redescription and figures of this species.[10]

Genus BIBRACTE Stål

BIBRACTE BIMACULATA sp. nov. Text fig. 9.

LUZON, Laguna Province, Los Baños, May 5 to 15, 1917, 4 males (including the type) and 8 females (*N. Ikonnikov*).

Male.—Body robust, size relatively large. Head with distinctly reclinate and practically smooth face; frontal costa slightly widened between antennal bases, distinctly narrowed to the fastigium, and equally broad below median ocellus; margins feebly raised, the surface between them feebly punctured, not rugose; eyes moderately prominent sideways, nearly twice as long as the subocular part of the genæ; interocular distance a little broader than the maximum width of the frontal ridge; supplementary facial carinæ well indicated, subparallel. Antennæ reaching a little beyond the posterior margin of pronotum.

Pronotum rugosely punctured, strongly tectiform, median keel strong, sharp, not very deeply interrupted by three transverse sulci, the third sulcus placed near the base of the second third;

[10] Zool. Mededeel. 11 (1928) 2–3, pl. 1, figs. 1–3.

seen in profile the keel is somewhat elevated in the anterior two-thirds, slightly concave behind the third sulcus and feebly elevated at the hind margin; the latter is very obtusely angulate, practically straight, with a feeble excision on the middle. Lateral lobes quite vertical in the lower part, with very distinct, elongated, oblique inflation in prozona placed between the hind transverse sulcus and the middle part of the anterior margin. Prosternal tubercle short, slender, sharply conical. Mesosternal interspace a little longer than broad.

Elytra strongly abbreviate, lateral, scalelike, somewhat shorter than pronotum, scarcely reaching the middle of the second abdominal tergite, widened apically and regularly rounded on the apex; postradial area a little broader than the preradial. Wings absent.

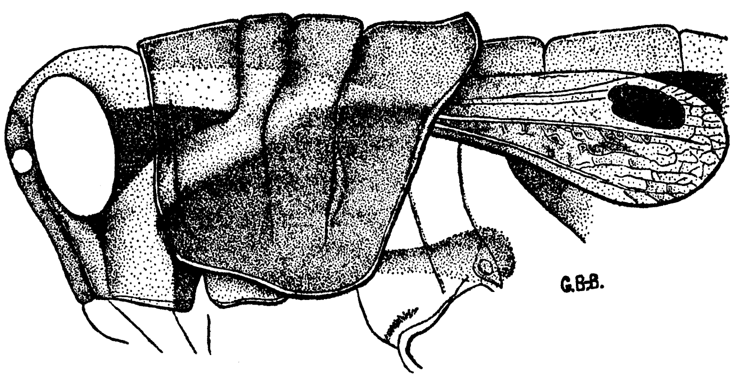

FIG. 9. *Bibracte bimaculata* sp. nov., head, pronotum, and elytra of the type, lateral view; × 10.

Abdomen with a very distinct, longitudinal, supra-anal plate, triangular, elongated, apex acute; basal half with a very distinct longitudinal furrow bordered with acute keels; cerci narrowly conical, relatively long, covered with relatively dense and long hairs, apex acute, subgenital plate short, obtusely conical, apex in profile rectangular. Hind femora relatively long, rather thick; hind tibiæ with seven or eight outer, and nine or ten inner spines; inner spines a little longer than the outer.

Female.—Like the male, but considerably larger and more robust. Antennæ extending beyond third transverse sulcus, but not reaching the hind margin of the pronotum. Mesosternal interspace scarcely broader than long. Supra-anal plate with less distinct longitudinal furrow in the basal half; apex rounded angulate, with very feeble and obtuse median excision; cerci short,

not reaching the apex of the supra-anal plate. Valvæ of the ovipositor densely pilose, relatively slender and long, upper pair somewhat longer than the lower, with feebly incurved apex, lower pair very narrow, with strongly narrowed and feebly incurved apical half.

General coloration brown or greenish brown, with black and pale stripes and spots, especially in the male sex. Antennæ blackish brown, except the lower surface of the basal half. Head pale or brownish, in male with a blackish postocular stripe. Pronotum with brownish disc and pale yellow postocular triangular spot in the prozona, including a dark triangular stripe, often indistinct in the female. Lateral lobes below the oblique inflation shining black (male) or dark brownish (female).

Elytra brownish, with very distinct preapical shining black spot, placed in the postradial field; rarely this spot is very feebly developed. Pleuræ pale yellow or brownish. Abdomen pale or pale brownish, with a broad, lateral, longitudinal, black stripe, often less indicated in female; lower surface dirty pale. Anterior and median legs with blackish and pale spots and fasciæ; hind femora in male with blackened external surface, including two pale yellow, somewhat oblique, spots not reaching the upper external keel; these spots are less indicated in female; upper surface dirty pale or brownish, with blackened spines on the upper keel; inner surface black, with pale median and preapical fasciæ, lower outer surface black, lower inner surface red; knee part not darkened, pale reddish or dirty pale. Hind tibiæ red or sometimes in female pale reddish; spines red, with blackened apices.

Length of body, male, 19.2 to 21 mm; female, 26.5 to 31; pronotum, male, 5 to 5.7; female, 7.1 to 8; elytra, male, 3.8 to 4; female, 5.8 to 6; hind femora, male, 13.1 to 14.3; female, 18 to 20.5.

This is the first species of the genus *Bibracte* from the Philippine Islands; it is very probable that *Bibracte backeri* Bolivar (in litt.) mentioned by Bruner[11] is identical with *B. bimaculata*. The new species resembles somewhat two Javanese species, which are also characterized by the strongly abbreviate, scalelike, elytra; namely, *B. diminuta* Brunner von Wattenwyl and, especially, *B. cristulata* Stål; but it differs from them in the shape of the elytra, in the not rugosely punctured and practically smooth

[11] Catalogue 257.

pronotum, in the coloration of the hind legs, and in the presence of a black spot on the elytra. From the known member of the genus *Gerenia* Stål (according to Doctor Willemse this genus is congeneric with *Bibracte*) the new species differs strongly in its scalelike elytra.

Genus EUCOPTACRA Bolivar

EUCOPTACRA CYANOPTERA (Stål).

Eleven males and eight females. This species was described from the Philippine Islands.

Genus CATANTOPS Schaum

CATANTOPS SPLENDENS (Thunberg).

Nine males and five females. A widely distributed Oriental species previously known from the Philippine Islands.

CATANTOPS HUMILIS (Serville).

Two males and four females. Although this is a widely distributed Oriental species it has not been known from the Philippine Islands.

TETTIGONIIDÆ

PHANEROPTERINÆ

Genus MIROLLIA Stål

MIROLLIA CINCTICORNIS Karny.

One male. This species was recorded by Bruner [12] from Los Baños under the same name, but without a description; recently it was fully described by Karny from the same place under Bruner's name.

Genus TAPIENA Bolivar

TAPIENA STYLATA sp. nov. Text fig. 10.

LUZON, Laguna Province, Los Baños, 1 male (*N. Ikonnikov*).

Closely allied to *T. cerciata* Hebard from Mindanao, Philippine Islands, but well separated from it in the structure of the cerci, the subgenital plate, and the very long style. Size large for the genus. Head with densely punctured face, occiput flattened, very feebly convex, with stronger and denser puncturation; fastigium of the vertex very small, strongly narrowing anteriorly, deeply sulcate, broadly triangular, basal part equal in width to the first antennal joint.

[12] Univ. Studies, Lincoln 15 N2 (1915) 82.

Disc of pronotum flat, strongly and densely punctured, posterior part scarcely wider than anterior; lateral lobes quite vertical, forming with a disc a right angle, their depth a little greater than width.

Elytra broad, reaching the apex of hind tibiæ, gradually narrowing to the apex, which is narrowly rounded; sector of the radial vein (Rs) branching on its median point, its base placed distinctly before the middle of elytra. Wings longer than elytra.

Last tergite simple, truncate posteriorly; supra-anal plate small, elongate, roundly triangular, deflexed between basal parts

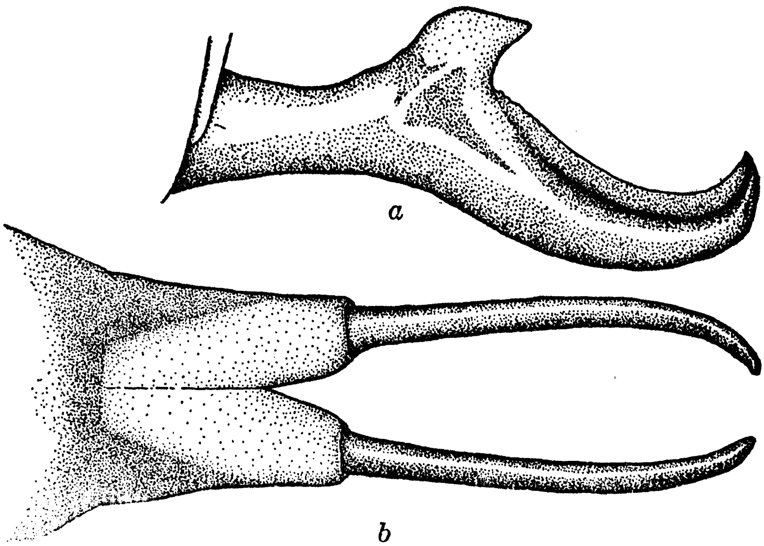

FIG. 10. *Tapiena stylata* sp. nov., *a*, left cerens of male, lateral view; *b*, subgenital plate and style of male, ventral view; greatly enlarged.

of cerci. Cerci large, basal third cylindrical, the other part depressed laterally with rounded lower margin and sharpened and lamellate upper margin; upper margin with a large and broad lamellate appendage placed a little before the middle of cercus; apical part gradually narrowing, its dorsal margin concave, apex sharpened, practically spiniform. Subgenital plate reaching the middle part of cerci, narrowing apically, with a narrow triangular excision on the apex, the branches cylindrical, with very slender and long filiform styli, which are narrowed and incurved apically; the apex of styli extending far behind the apex of cerci. The armature of ventral margins of femora with small teeth are as follows: Anterior femora with four in-

ner, and no outer spine; middle femora with no inner, and one outer spine; hind femora with three or four inner and six outer spines.

General coloration green. Head, pronotum, abdomen, and femora greenish yellow (probably discolored); elytra with some very small and indistinct dark spots in posterior part.

Length of body, 28 mm; pronotum, 6.9; anterior width of pronotum, 43; depth of lateral lobes, 5.2; length of elytra, 41.5; maximum width of elytra, 10.4; length of hind femora, 17.9; styli, 4.

The type is unique.

This easily separated species shows a very close morphologic and geographic affinity to *T. cerciata* Heb.

Genus CASIGNETA Brunner von Wattenwyl

CASIGNETA SPINICAUDA Karny.

One female. This species was described by Karny[13] from Mount Maquiling, Luzon, which is in the vicinity of Los Baños.

Genus PHAULA Brunner von Wattenwyl

PHAULA PHANEROPTERVIDES Brunner von Wattenwyl.

One female. This species is known only from the Philippine Islands.

Genus EUANEROTA Karny

EUANEROTA FURCIFERA (Stål).

Four males and seven females. This species has been recorded only from the Philippine Islands.

Genus DUCETIA Stål

DUCETIA JAPONICA Thunberg.

One male and four females.

PSEUDOPHYLLINÆ

Genus PHYLLOMIMUS Stål

PHYLLOMIMUS DETERSUS (Walker).

One female. A widely distributed Malayan species.

CONOCEPHALINÆ

Genus XIPHIDION Serville

XIPHIDION AFFINE Redtenbacher.

One male.

[13] Philip. Journ. Sci. 18 (1921) 614.

XIPHIDION MACULATUM Le Guillon.

Six females. Two very common and widely distributed species.

AGRÆCIINÆ

Genus CORYPHODONTA novum

Superficially very similar to the genus *Salomona* Blanchard, but not intimately related to it and showing the closest affinity to *Acanthocoryphus* Karny, of Tonkin; from the last-mentioned genus it differs as follows:

Face shallowly impressed-punctate; fastigium of the vertex shorter, not spiniform, slightly longer than its basal width, subequal in length to the first antennal joint. Disc of pronotum with feeble but distinct transverse impression at the hind transverse sulcus. Lateral lobes distinctly longer than their vertical depth, lower margin oblique, with a distinct obtuse angulate excision before lower anterior angle, humeral sinus well indicated. Elytra and wings fully developed, reaching the apex of ovipositor. Lower margin of femora armed with large and small spines; genicular lobes of the anterior and middle femora unispinose on the inner side and roundly produced on the outer side, genicular lobes of hind femora with relatively long spinula on each side. Subgenital plate short, with hind margin truncate.

Genotype.—*Coryphodonta ikonnikovi* sp. nov.

This genus includes also *Acanthocoryphus mindanensis* Hebard, recently described from Mindanao, Philippine Islands,[14] which is closely allied to *C. ikonnikovi* sp. nov., described below.

CORYPHODONTA IKONNIKOVI sp. nov. Text fig. 11.

LUZON, Laguna Province, Los Baños, May 15, 1917, 1 female (*N. Ikonnikov*).

Female.—In general habitus and structure very like *C. mindanensis* Hebard (described as a member of the genus *Acanthocoryphus* Karny) and differing from it in the structure of the vertex and in many other features.

Body robust, a little smaller than body of *C. mindanensis*. Head very large and broad; fastigium of vertex short-conical, apex rounded, dorsal surface armed with a simple relatively small tubercle, in the basal half, a little before the middle of fastigium; occiput not punctured.

[14] Proc. Acad. Nat. Sci. Phila. (1922) 227–229, pl. 18, figs. 10 and 11.

Disc of pronotum flattened, very densely but not coarsely rugulose, hind margin truncate; first transverse sulcus feebly indicated, at the base of the anterior third, the second (principal) sulcus well developed, a little behind the middle of pronotum. Lateral lobes rugulose, with sulci distinct. Elytra extending beyond the apex of hind femora at a distance equal to half the length of hind femora, gradually narrowing apically. Anterior femora moderately heavy, subparallel-sided, lower inner margin armed with a large spine preceded by one or two small spines, followed by gradually decreasing three or four small spines and then a larger spine somewhat before the apex of femora; median femora feebly but distinctly narrowed apically, lower external margin with three large spines of which the middle is the largest, and with one and three small spines between them; hind femora with five or six large spines on the lower outer margin and with a few small spines, none to two, in the intervals between the large spines. Prosternum and middle coxæ unarmed. Subgenital plate very short, transverse, rectangular. Ovipositor unarmed, feebly incurved upwards, dorsal margin of the flattened part straight, lower margin roundly incurved; regularly narrowing and sharpened apically, maximum width on the middle.

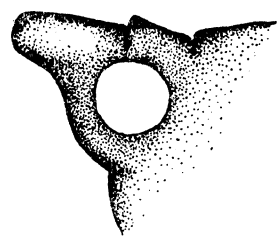

FIG. 11. *Coryphodonta ikonnikovi* gen. et sp. nov., fastigium of vertex of the female type, lateral view, greatly enlarged.

General coloration light brown. Head unicolorous, except lower surface of the fastigium of vertex, fastigium of front, and a small space surrounding the median ocellus, which are olive-green; lower part of the labrum reddish. Disc of pronotum darker than head and lateral lobes. Elytra light brown, with numerous dark spots, especially in the anterior field and along the sutural margin. Legs, abdomen, ovipositor, and antennæ light brown, without a dark color, except antennæ which have some very sparse dark rings, especially in the basal part.

Length of body, 28.5 mm; fastigium of vertex, 1.2; pronotum, 8.5; posterior width of pronotal disc, 5.5; length of elytra, 25; width of elytra, 6.2; length of hind femora, 14.8; ovipositor, 13.3; maximum width of ovipositor, 2.2.

The type is unique.

Besides the difference in the structure of the fastigium of vertex the new species is easily separated from *mindanensis* by its smaller size, the nonpunctured occiput, the shape of the elytra, and the coloration.

Hebard wrote in the description of his *Acanthocoryphus mindanensis* that this species "is widely distinct from *A. brongniarti* Karny described from Tonkin but no characters warranting generic separation can be determined." But the discovery of the second similar species in the Philippine Islands with the same general morphology as *mindanensis* reveals (after a careful comparison of these species with the description and excellent figure of *Acanthocoryphus brongniarti*)[15] many morphological differences, described above, between the Philippine species and the genotype of *Acanthocoryphus*. On the other hand there is a relatively broad geographic separation between *Acanthocoryphus* and *Coryphodonta* gen. nov., which is another good reason for the separation of these two genera.

[15] Revisio Conocephalidarum (1907) 72, fig. 17.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Diotarus ikonnikovi* sp. nov., the female type, lateral view; × 6.
2. *Bolotettix luzonicus* sp. nov., head and pronotum of the type, dorsal view; × 10.
3. *Paratettix* (?) *palpatus* sp. nov., *a*, head and pronotum of the type, lateral view; × 6; *b*, maxillary palpus, greatly enlarged.
4. *Paratettix platynotus* sp. nov., head and pronotum of the type, dorsal view; × 6.
5. *Eoscyllina luzonica* Bolivar, apex of hind tibia of female, greatly enlarged.
6. *Ikonnikovia philippina* gen. et sp. nov., the female type, lateral view; × 4.
7. *Pseudogerunda willemsei* gen. et sp. nov., head, pronotum, and elytra of the type, lateral view; × 7.5.
8. *Binaluacris polychroma* sp. nov., head, pronotum, and elytra of the type, dorsal view; × 7.5.
9. *Bibracte bimaculata* sp. nov., head, pronotum, and elytra of the type, lateral view; × 10.
10. *Tapiena stylata* sp. nov., *a*, left cerens of male, lateral view; *b*, subgenital plate and style of male, ventral view; greatly enlarged.
11. *Coryphodonta ikonnikovi* gen. et sp. nov., fastigium of vertex of the female type, lateral view, greatly enlarged.

THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, P. I.

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Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 302, Manila, P. I., or to any of the agents listed below.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Scientific Library, Bureau of Science, post-office box 774, Manila, P. I.

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The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbashi, Tori-Nichome, Tokyo, Japan.

CONTENTS

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 57, NO. 4 AUGUST, 1935

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1935

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 57 AUGUST, 1935 NO. 4

THE SOIL OF TAGAYTAY RIDGE, CAVITE

By D. Z. ROSELL and A. S. ARGÜELLES
Of the Bureau of Science, Manila

ONE PLATE AND ONE TEXT FIGURE

Tagaytay Ridge in Cavite Province, Luzon, has been considered as a future health resort and possibly a second summer capital of the Philippines. Since, moreover, this region is located near Manila it would be a good place for raising vegetables and fruits for the Manila market, provided the local conditions justify such an agricultural development on a large scale.

The object of this investigation was to obtain information concerning the climatic and geologic conditions of Tagaytay Ridge and particularly to study the morphological, physical, and chemical characteristics of the soil.

Before the opening of the Tagaytay road to Batangas, a large portion of Tagaytay Ridge was a veritable cogon, *Imperata cylindrica* (Linn.), and talahib, *Saccharum spontaneum* Linn., area. Since the opening of this road there has been considerable agricultural development in this region, and at present a large portion of Tagaytay Ridge is under casual cultivation with various crops.

Formerly abacá, *Musa textilis* Née, was the lucrative crop, but the bunchy-top disease wiped out this plant completely. The areas thus vacated have been used for other purposes. Upland rice, planted once a year during April and May, is the most important staple crop.

Corn, next to rice in importance and acreage, is planted in rotation with rice. It is either allowed to mature or sold green at Mendez and other important points along the road. The

mature corn is sold, shelled or unshelled, for much less than the prices received for the green corn.

The yield of corn and other crops has never been ascertained accurately, because neither the tenants nor the landlords pay much attention to the area planted and the amount harvested. They merely estimate roughly whether the yield is good or poor.

Truck gardening is considered quite profitable. The tomato grows very well, and it has been reported that an eighth of a hectare will yield a crop of tomatoes valued at about 50 pesos.

Bananas are planted here and there along the sides and in the corners of the fields. Chayote, *Sechium edule* S. W., a newly introduced tropical vegetable of climbing habit, is also gaining in popularity among the farmers. The sandy loam soil and the cool climate of Tagaytay are very suitable for the cultivation of this plant, which is now grown in Baguio and sold in Manila.

Other crops that are popular in this region are peanuts, camotes, mustard, and pechay.

DESCRIPTION OF THE AREA

The location of Tagaytay Ridge is shown in the map (text fig. 1), which was taken from Father Selga's report.(1) The ridge (Plate 1) is the summit of a flat-topped area lying between Batangas and Cavite Provinces. From the bay shore of Manila the ridge appears to be an elevated table-land extending from Mount Sungay (753 meters) southwest to Balibaguhan, which is a short distance northeast of Mount Batulao (812 meters). With an elevation of about 600 meters, maintained with a very slight undulation throughout its entire length of approximately 20 kilometers, the ridge overlooks Taal Volcano, Verde Island Passage, and a portion of Mindoro on the south side, and Manila Bay and its environs on the north side. The highest portion has a width of 2 to 3 kilometers. From this location there is a gradual descent northwestward to Manila Bay.

L. A. Faustino, assistant director of the Bureau of Science, described Tagaytay Ridge geologically as representing a portion of the crater rim of an old, mighty volcano, the predecessor of the present Taal.(1) It consists of a series of consolidated volcanic tuff deposits, the products of a long series of volcanic explosions.

The Manila-Cavite-Batangas road via Indang passes through the ridge. The Manila-Silang road, when continued to Tagay-

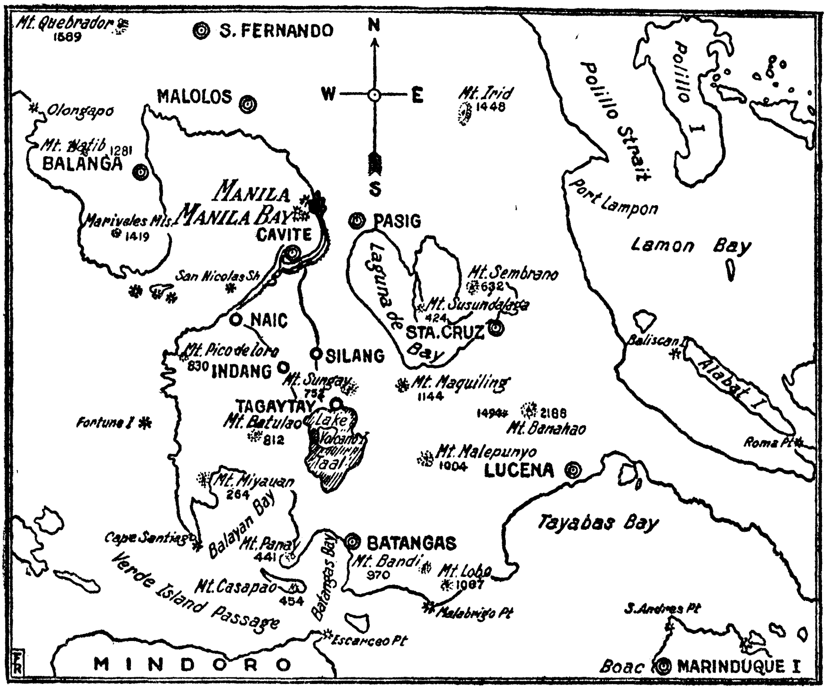

FIG. 1. Map of Cavite Province, showing Tagaytay and neighboring regions.

tay, will meet the Manila-Cavite-Batangas road and form a junction at about the middle of the ridge. A first-class road connects this junction with Manila via Indang. The distance is 78 kilometers. The towns of Mendez and Indang are now the primary markets for the farm produce of this region. Transportation of the products is facilitated by both the Batangas and the Cavite Transportation Companies.

At present the small number of people living at Tagaytay Ridge are mostly tenants employed by land owners. These tenants live in small temporary huts ("kubo"). The land owners who superintend the cultivation of the land live in the towns of Mendez, Alfonso, Amadeo, and Silang.

As there are no springs on Tagaytay Ridge, the people of Mendez pipe their drinking water from Kay-bubutong Spring. This is situated approximately 1,200 meters south of and 250 meters below the top of Tagaytay Ridge. The spring constitutes the headwaters of Bubutong River, which flows into Taal through the barrio of Birinayan near Talisay, Batangas. According to the Director of Public Works the spring has a flow of approximately 800 gallons per minute, or 1,152,000 gallons per day.(1) This is sufficient for 57,600 people based on a consumption of 20 gallons a day for each person.

CLIMATE

The Weather Bureau has made meteorologic observations for two years to get information concerning the weather and climate at Tagaytay. Generally it is dry in winter and spring and wet in summer and autumn.

TABLE 1.—*Average temperature and rainfall of Tagaytay Ridge, Manila, and Baguio.*[a]

Temperature.	Station.	Period of observation.	Monthly records.					
			January.	February.	March.	April.	May.	June.
		Years.	°C.	°C.	°C.	°C.	°C.	°C.
Mean	Manila	1885–1929	24.7	25.3	26.5	28.1	28.4	27.8
Do	Tagaytay	1928–1930	20.2	21.2	24.4	23.6	24.0	23.6
Do	Baguio	1901–1928	16.8	16.9	18.1	19.0	19.0	18.8
Maximum	Manila	1885–1929	30.1	31.0	32.6	34.1	33.7	32.4
Do	Tagaytay	1928–1930	24.0	25.8	27.3	28.6	28.4	27.6
Do	Baguio	1909–1918	22.5	22.8	24.2	24.9	24.2	23.9
Minimum	Manila	1885–1929	20.4	20.4	21.3	22.8	24.0	24.0
Do	Tagaytay	1928–1930	16.4	16.7	17.6	18.4	19.4	19.6
Do	Baguio	1909–1918	13.0	13.1	14.2	15.3	16.0	16.1
Rainfall..mm.	Manila	1865–1929	24.3	11.3	18.2	31.6	116.6	253.6
Do	Tagaytay	1928–1930	29.2	1.2	35.4	42.9	193.2	125.2
Do	Baguio	1902–1929	23.3	20.1	45.0	115.3	387.0	469.6
Rainy days	Manila	1866–1929	5	3	3	4	10	17
Do	Tagaytay	1928–1930	12	2	5	6	18	26
Do	Baguio	1902–1929	4	4	6	10	21	24

Temperature.	Station.	Period of observation.	Monthly records.					
			July.	August.	September.	October.	November.	December.
		Years.	°C.	°C.	°C.	°C.	°C.	°C.
Mean	Manila	1885–1929	26.9	26.9	26.8	26.5	25.8	25.0
Do	Tagaytay	1928–1930	22.6	22.8	22.2	22.0	21.6	20.5
Do	Baguio	1901–1928	18.2	17.9	18.1	18.2	18.0	17.5
Maximum	Manila	1885–1929	31.0	30.7	30.8	31.1	30.5	30.0
Do	Tagaytay	1928–1930	25.6	25.9	25.2	25.2	25.0	24.2
Do	Baguio	1909–1918	21.9	21.5	21.9	22.9	23.5	23.2
Minimum	Manila	1885–1929	23.7	23.8	23.7	23.1	22.2	21.2
Do	Tagaytay	1928–1930	19.5	19.8	19.2	18.8	18.2	16.8
Do	Baguio	1909–1918	15.8	15.6	15.6	15.3	14.8	14.1
Rainfall..mm.	Manila	1865–1929	421.4	414.2	357.1	189.7	137.6	60.5
Do	Tagaytay	1928–1930	521.1	286.4	496.2	271.0	170.2	69.4
Do	Baguio	1902–1929	1,023.2	1,202.2	729.9	367.6	89.0	42.5
Rainy days	Manila	1866–1929	22	22	21	17	13	9
Do	Tagaytay	1928–1930	28	22	28	20	24	20
Do	Baguio	1902–1929	28	27	25	18	9	6

[a] Selga, M., Bur. Sci. Pop. Bull. 6 (1930).

Data on the temperature and rainfall of Tagaytay compared with those of Manila and Baguio are given in Table 1, which was also taken from Father Selga's report.(1) The average temperature of Tagaytay varies between 20.2° and 24° C. and is almost the same as the mean minimum of Manila.

The average annual rainfall of Tagaytay is about one-fifth greater than that of Manila and almost one-half that of Baguio. The actual figures are: Tagaytay, 2,241.4 mm; Manila, 2,036.1 mm; and Baguio, 4,314.5 mm. During the northeast monsoon Tagaytay has more rainy days than either Manila or Baguio. The sky is rarely clear. In the daytime Tagaytay has more humidity than Manila, but there is usually a moderately cool breeze that is conducive to health and comfort.

EXPERIMENTAL PROCEDURE

In our investigation of the soil of Tagaytay we first made a detailed inspection of the region. Borings were made to determine the character of the soil at different strata. Sites were selected for taking representative soil samples. The samples were then analyzed chemically and their physical properties examined. Tests used especially in soil investigations were carried out as follows:

pH value indicating the degree of acidity or alkalinity of the soil.—This was determined by Dr. M. M. Alicante, of the Bureau of Science, who used an electrical method, employing the antimony electrode. The results are expressed according to a scale in which pH 7.0 corresponds to neutrality. Values numerically less than pH 7.0 indicate acid soils and those greater than pH 7.0 alkaline soils as shown by the following data:

pH value.	Soil reaction.
7.5 to 7.0	Alkaline.
7.0 to 6.5	Slightly acidic.
6.5 to 6.0	Acidic.
6.0 to 5.5	Markedly acidic.
5.5 to 5.0	Highly acidic.

Index of texture (degree of clayiness).—This figure is derived from two physical soil constants;(2) namely: (*a*) Moisture of the soil at the point of stickiness (M. P. S.); the results are expressed as the percentage of moisture for oven-dried soils. (*b*) The proportion of coarse to fine sand; the percentages are determined by the pipette method.

In general the index of texture equals the moisture content at the point of stickiness less one-fifth of the percentage of sand.

$$\text{I. T.} = \text{M. P. S.} - \frac{\text{Per cent sand}}{5}$$

A description of soils according to the texture index is as follows:

Texture index.	Kind of soil.
60 to 55	Heavy clay.
55 to 50	Clay loam.
50 to 40	Loam or silt loam.
40 to 25	Sandy loam.
25 to 10	Sand.

Percolation rate of water.—For this determination we used the method described by Bouyoucos.(3) This method consists in keeping the soil immersed in an excess of water, applying suction (maintained at constant pressure), and measuring the rate at which the water passes through the soil.

The apparatus consisted of a Buchner funnel connected to a graduated cylinder by means of a two-holed rubber stopper. The Buchner funnel was about 5 centimeters in diameter and 4 centimeters in depth. The cylinder had a capacity of 500 cubic centimeters.

The soil (100 grams) was soaked with water and poured into the Buchner funnel on top of filter paper, previously placed in the bottom of the funnel. The suction was then applied, and during the filtration care was taken to have the soil continually immersed in water. This was done by pouring water over a spoon and on to the soil so that the force of the water would not disturb the settled condition of the soil. The percolate was measured after about 100 cubic centimeters, or more, of water had passed through the funnel.

Water-holding capacity.—An approximate and simplified method, based on the principle of the Keen-Raczkowski box experiment,(4) was used for this determination. Instead of a box, a perforated brass cup 5 centimeters in diameter was employed. A coarse filter paper was placed in the bottom of the cup, after which the cup was soaked in water, drained, and weighed. It was next filled with soil and weighed again. The cup with soil was then soaked in water for two hours and drained for two hours; it was weighed three times at intervals

of thirty minutes. The increase in weight represented the amount of water held by the soil.

TABLE 2.—*Mechanical analysis of Tagaytay sandy loam soil.*

Horizon of soil.	Depth from surface.	Coarse sand; 2 to 0.22 mm.	Medium sand; 0.22 to 0.14 mm.	Fine sand; 0.14 to 0.07 mm.	Very fine sand; 0.07 to 0.05 mm.	Silt; 0.05 to 0.005 mm.	Clay; 0.005 mm.	Solution loss.[a]
	cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Surface soil "A"	24	16.5	9.2	11.6	12.2	24.2	25.9	0.4
Subsoil (Zone "B")	24–60	4.8	4.4	5.1	10.6	28.3	46.4	0.4
Subsoil (Zone "B[1]")	60–100	5.0	4.6	3.8	11.7	21.7	52.4	0.8
Substratum "C"	100–130	5.0	9.5	7.2	13.2	16.4	46.8	1.9

[a] The solution loss is obtained by treating the sample with hydrogen peroxide and washing.

RESULTS

Mechanical analysis.—The mechanical analysis of the Tagaytay soil was made in accordance with the method of Olmstead, Alexander, and Middleton.(5) The results are given in Table 2. The surface soil(6) (A), the horizon of volcanic origin, is a coarse, granular, and friable sandy loam. The eruption of Taal Volcano in past years brought considerable loose volcanic material to this ridge. Deposits of such material have made a sandy loam soil that is very dark brown or nearly black in color. This character of soil ranges in depth from 50 centimeters for the deepest deposits along the top of the ridge to 12 centimeters for the shallow ones that lie on the northwestern side of the ridge about 1 to 2 kilometers below the top. This soil is granular in structure and friable in consistency. It is easily pulverized or reduced to crumb structure.

The subsoil (zones B and B[1]) is loam to clay loam in texture, very dark brown to nearly black in color, and granular to pulverulent in structure. Like the surface soil it is friable in consistency, and easily worked, crumbled, or pulverized.

The lower horizon (substratum C) is the parent material of the subsoil immediately above it. It is reddish brown in color, heavy clay in texture, and gradually becomes adobe clay as it extends downward. The adobe structure is strongly dominant in the lower section of the C horizon, thus the name adobe clay.(7)

Color of the soil.—The most important characteristic of Tagaytay sandy loam soil is the very dark to nearly black color of the surface soil. In general the color of a soil is dependent upon the content of organic matter and ferric oxide, the latter being more or less hydrated.(8) The presence of organic matter tends to blacken the soil and ferric oxide reddens it. The dark coloration of the surface soil (A) and the fairly high loss on ignition (Table 5) indicate that the soil has sufficient organic matter.

Soil profile.—The morphological and physical characteristics of the soil profile of Tagaytay sandy loam are given in Table 3.

TABLE 3.—*The morphological and physical characteristics of the soil profile of Tagaytay sandy loam.*

Depth of zone.	Morphological characteristics.	Physical properties.		
		Index of texture.	Water-holding capacity.	Percolation rate.
cm.			*Per cent.*	*cc per hour.*
4	Plant residues and mineral materials.			
	Very dark brown to nearly black sandy loam; granular and mealy in structure; friable and loose in consistency.	37.00	50.16	1,196.4
24	Very dark to nearly black loam grading into clay loam; granular in structure and friable in consistency.	61.89	53.94	382.1
60	Reddish brown clay loam grading into clay; coarse granular in structure and loose in consistency. Reddish brown concretions present.	71.74	64.05	348.2
100	Parent materials. Yellowish brown to reddish brown adobe clay; soft adobe stones extending to indefinite depth.	74.87	68.83	196.7

The locality of this profile was situated about the middle of Tagaytay Ridge and is representative of this region. The index of texture, water-holding capacity, and percolation rate are given for each particular zone in this profile. As shown by the data (Table 3) the index of texture and water-holding capacity increase with the depth of the horizon, while the percolation rate decreases.

As a check on these data four representative soil samples, taken from other locations, were tested for their physical properties. The results (Table 4) were about the same as those recorded in Table 3.

TABLE 4.—*Physical properties of four representative samples of surface soils, subsoils, and substrata of the Tagaytay sandy loam soil.*

Horizon of soil.	Depth from surface.	Physical properties.		
		Index of texture.	Water-holding capacity.	Percolation rate.
	cm.		*Per cent.*	*cc per hr.*
Surface soil [a]	15– 50	39.43	50.10	1,719.2
Subsoil [b]	50– 70	64.89	59.61	510.0
Substratum [c]	60–130	69.03	59.03	216.3

[a] The surface soil is a very dark brown to nearly black sandy loam.
[b] The subsoil is a dark brown clay loam.
[c] The substratum is a reddish brown adobe clay soil.

The rolling topography of the ridge and the low percolation rate of the subsoil are conducive to erosion processes.(9) However, the coarseness of the surface soil and its rapid percolation rate (Tables 3 and 4) tend to minimize the erosive activity.(10) The Tagaytay sandy loam soil will be subject to detrimental erosion processes, which will ruin the fertility if proper husbandry of the soil is not utilized.(11)

Chemical analysis.—The soil samples were analyzed in accordance with the methods of the Association of Official Agricultural Chemists. The elements determined were nitrogen, potassium, phosphorus, calcium, and magnesium. The results of the analyses are given in Table 5. The reaction of the surface soil is slightly acidic and the acidity increases with the depth of the soil. The nitrogen content, phosphorus, lime, loss on ignition, and organic carbon decrease with depth of soil.

Dr. M. M. Alicante, of the Bureau of Science, has analyzed soils of the Don Pedro districts, such as Balayan, Nasugbu, Palico, Liang, and Tuy, which are near Tagaytay Ridge. Comparing these results with the analyses of Tagaytay Ridge soil (Table 6) the following conclusions may be drawn:

The average nitrogen and magnesium contents of the Tagaytay Ridge soil are higher than those of the Don Pedro districts, but the phosphoric anhydride, potash, and lime contents are somewhat lower.

In plant-food constituents, particularly nitrogen, the Tagaytay sandy loam soil has a sufficient amount to insure good crops under favorable weather conditions. Vegetables and fruits of good quality could easily be cultivated in this region and they would have a ready sale in Manila markets.

TABLE 5.—*Average chemical analyses of four representative samples of surface soils, subsoils, and substrata of the Tagaytay sandy loam soil.*

Horizon of soil.	Depth from surface.	pH value.	Nitrogen (N).	Phosphoric anhydride (P_2O_5).	Potash (K_2O).
	cm.		*Per cent.*	*Per cent.*	*Per cent.*
Surface soil [a]	15– 50	6.06	0.169	0.236	0.373
Subsoil [b]	50– 70	5.99	0.148	0.225	0.206
Substratum [c]	60–130	5.73	0.070	0.142	0.246

Horizon of soil.	Depth from surface.	Lime (CaO).	Magnesia (MgO).	Loss on ignition.	Organic carbon.
	cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Surface soil [a]	15– 50	3.20	1.39	15.77	4.58
Subsoil [b]	50– 70	1.77	1.11	12.03	3.42
Substratum [c]	60–130	1.17	1.35	11.46	2.92

[a] The surface soil is a very dark brown to nearly black sandy loam.
[b] The subsoil is a dark brown clay loam.
[c] The substratum is a reddish brown adobe clay.

TABLE 6.—*Comparative analyses of Tagaytay Ridge soil and soils of the Don Pedro (Central Azucarera) districts, Batangas.*[a]

Location of soil.	pH value.	Nitrogen (N).	Phosphoric anhydride (P_2O_5).	Potash (K_2O).	Lime (CaO).	Magnesia (MgO).
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Tagaytay Ridge	6.06	0.169	0.236	0.373	3.20	1.39
East Balayan	6.92	0.058	0.345	1.188	5.299	1.048
West Balayan	6.92	0.070	0.337	0.994	4.011	1.058
Nasugbu and Palico	7.04	0.100	0.330	0.823	2.852	1.006
Liang	7.12	0.098	0.362	0.753	3.285	0.907
Tuy	7.29	0.076	0.316	0.776	3.343	1.411

[a] Monthly Reports of the Research Bureau, Philippine Sugar Association 5 (1933) 367.

Danger of exhausting the plant food due to erosion processes and a careless cropping system is imminent, but careful husbandry will minimize the loss of fertility and preserve the usefulness of the soil.

SUMMARY

The soil reconnaissance made at Tagaytay Ridge covers an area of approximately 1,500 hectares. The soil type established in this area is Tagaytay sandy loam soil.

The surface, or A horizon, is very dark brown to nearly black in color; coarse granular in structure, and friable in consistency. It is volcanic in origin with a deposit that varies in thickness from 12 to 50 centimeters. The subsoil (B and B [1]) horizon is very dark brown in color and varies from loam to clay. The substratum (C horizon) is reddish brown clay and coarse granular to adobe clay. The dark coloration of the surface soil is indicative of abundant organic matter, a fact verified by the chemical analysis.

The rolling topography of the land and the physical characteristics of the subsoil (friable in consistency, granular in structure, and low percolation rate) are favorable factors for soil erosion. The erosion process, however, will be minimized by careful husbandry of the soil.

The percentage of nitrogen in the soil is fairly high; the phosphoric anhydride and the potash are about normal. The pH reaction is slightly acidic.

The Tagaytay soil has sufficient potential plant-food constituents to produce a good yield of crops under favorable weather conditions, and this region would seem to be a good location for truck gardening on a large scale.

Baguio vegetables are now sold in the Manila markets. Tagaytay Ridge is more convenient than Baguio for raising produce to supply the Manila markets, for the distance from Manila to Tagaytay (78 kilometers) is much less than from Manila to Baguio (278 kilometers).

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ILLUSTRATIONS

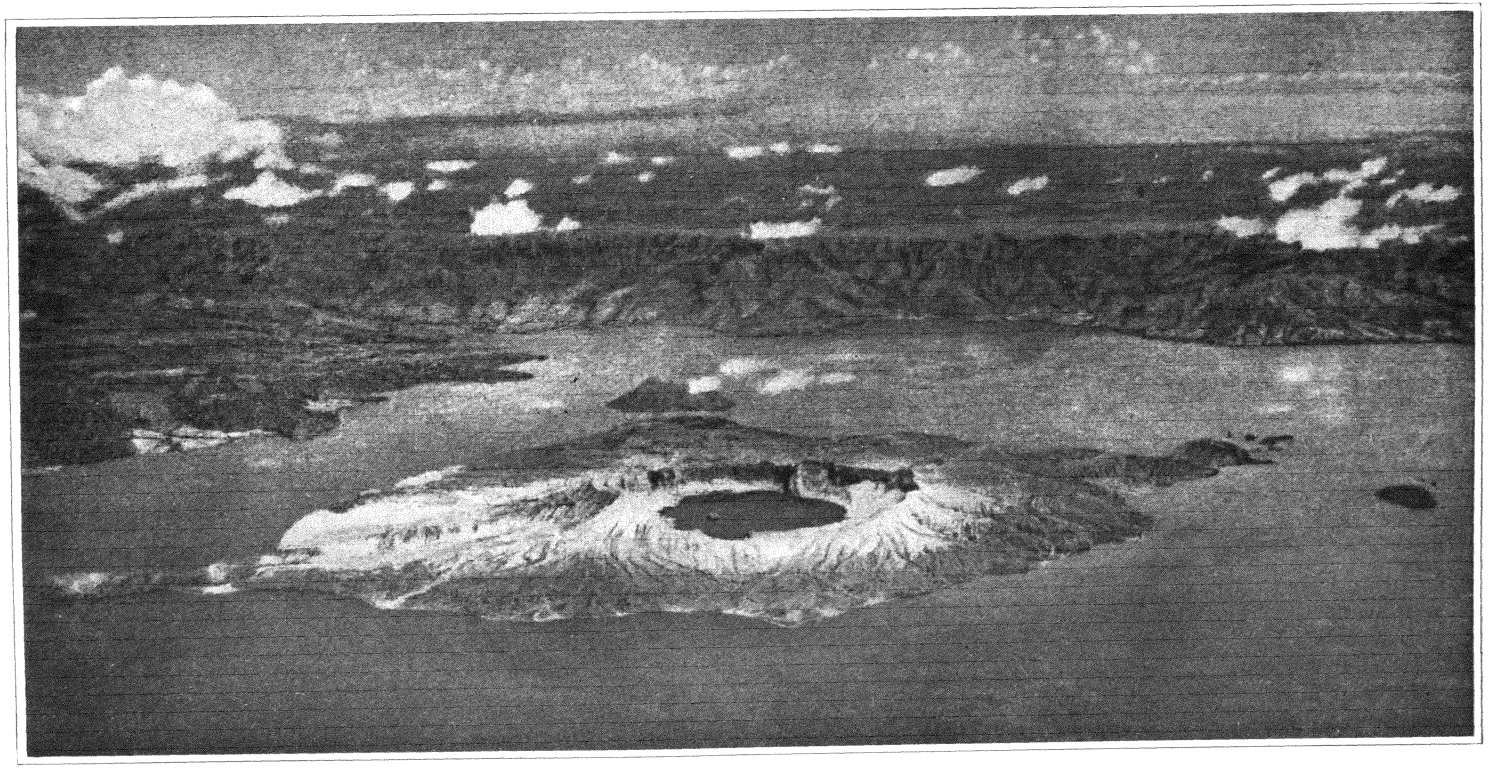

PLATE 1.

PRODUCTS FROM COCONUT-OIL WAX

By SIMEONA SANTIAGO TANCHICO

Of the Bureau of Science, Manila

In the Philippine coconut-oil mills it is customary to store the oil in large tanks preparatory to shipment abroad. Sometimes the oil is allowed to remain in the tanks for some months. During storage a sediment gradually separates and is deposited on the bottom of the tank. Jakobsen[1] investigated a similar sediment that occurs in refined linseed oil and found it to be a wax.

A supply of the coconut-oil residue was obtained from one of the Philippine oil mills, and some preliminary experiments were carried out to ascertain if products of commercial value could be made from it.

EXPERIMENTAL PROCEDURE

Purification.—The crude residue, which contained a large amount of coconut oil, was purified in the following manner: The mixture was filtered through paper to remove most of the oil. The impure residue was placed in a flask and heated on a water bath (temperature, 80° C.) until most of the material melted. It was then filtered through a hot-water funnel to remove dust and other impurities. The residue was dissolved in hot kerosene; the solution was treated with decolorizing carbon (suchar) and filtered. The filtrate was treated with talcum powder, to remove particles of carbon. When the clear solution was cooled in ice water, white crystals separated out. These were removed by filtering and dried between layers of filter paper. The crystals were washed repeatedly with acetone in order to remove the last traces of kerosene. The melting point was 93° to 96° C.

The yield was not calculated, for the amount of solid material contained in samples of oily residue from different coconut-oil mills varied considerably. No definite information could be obtained as to the exact amount of residue that is deposited in the mill tanks as these data have never been ascertained. At one mill it was surmised that 500 tons of coconut oil stored for about three months would yield, perhaps, 40 kilos of sediment.

[1] Cotton Oil Press 6 (1922) 43.

At others where the oil was stored longer the estimates ran much higher.

Solubility.—Solubility experiments showed that the purified crystals dissolved readily in hot amyl alcohol, benzene, chloroform, isobutyl alcohol, isopropyl alcohol, propyl alcohol, and toluene. They are also fairly soluble in hot ethyl alcohol, but are only slightly soluble in benzyl alcohol, ethyl acetate, petroleum ether, methyl alcohol, ether, and acetone.

Constituents.—As stated later, when the purified crystals were decomposed (saponified) the reaction products were found to contain no glycerin. This coconut-oil residue is therefore not an ordinary fat (glyceride). Although it is insoluble in water, it has the property of forming emulsions with water. This would suggest that this material is a wax.

In order to get some idea as to the composition of the coconut-oil residue the refined material was first decomposed into its constituents by saponification. Ten grams were treated with potassium hydroxide (1.6 grams), dissolved in a few cubic centimeters of water, to which were added ethyl alcohol (15 cubic centimeters) and propyl alcohol (35 cubic centimeters). The mixture was heated on a water bath for two days to complete the reaction.

The saponified product was poured into large beakers and diluted with a large amount of water. The precipitate was removed by filtering, which was a rather slow process, washed well with water, dried between layers of filter paper, and crystallized from warm ether solution. The white crystals had a melting point of 88° to 90° C. They were almost insoluble in cold alcohol but dissolved readily in hot alcohol. These data indicated that these crystals consisted largely of myricyl alcohol.[2]

When the filtrate from the crystals containing myricyl alcohol was acidified with dilute sulphuric acid, there was obtained a flocculent white precipitate. This was separated by filtering, washed with water, and dried between layers of filter paper. When crystallized from hot chloroform, white crystals melting at 78° to 80° C. were obtained. The melting point indicated that these crystals consisted mostly of cerotic acid.[3]

The aqueous filtrate from the precipitated organic acid was evaporated to a small volume (about 12 cubic centimeters) and

[2] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats and Waxes 1 (1921) 246.

[3] Op. cit. 1 (1921) 173.

tested for glycerin. The bisulphite test gave no acrolein odor and the silver-mirror test was also negative. These experiments show that the purified coconut-oil residue does not yield glycerin as a decomposition product and is, therefore, not a glyceride. This residue would appear to be a wax containing the myricyl ester of cerotic acid.

COMMERCIAL PRODUCTS

The basic material used for these preparations was the crude coconut-oil residue. This was filtered to remove most of the coconut oil. It was then melted and again filtered to eliminate dust and other impurities.

Floor wax.—The ingredients for this product were mixed in accordance with the following proportions:

Constituent.	Per cent.
Coconut-oil wax	32
Carnauba wax	15
Hercules rosin	3
Tallow	21
Turpentine	29
Total	100

The solid materials were melted together over a small flame. The flame was then extinguished and the turpentine and some coloring matter were added. The mixture was stirred thoroughly and poured into a container, which was stoppered tightly to prevent loss of solvent. The container was immersed immediately in ice water in order to solidify the mixture quickly as otherwise the ingredients tend to separate in layers.

The coloring matter was made by extracting a quantity of annatto seeds (*Bixa orellana* L.) with turpentine. The amount of dye solution to be added depends upon the color desired.

The consistency of the floor wax may be varied by combining the constituents in somewhat different quantities.

Furniture polish.—The materials were mixed in the proportions given below:

Constituent.	Per cent.
Stearic acid	7
Triethanolamine	2
Carnauba wax	21
Coconut-oil wax	11
Turpentine	26
Water	33
Total	100

The triethanolamine and the stearic acid were treated with the water and the mixture heated and stirred until it was uniform. The waxes were melted together and, after the addition of turpentine, the wax mixture was poured into the stearic acid solution previously prepared. The combined ingredients were stirred vigorously until the emulsion was homogeneous.

Polishes of this type may be used where a permanent finish is desired. They require considerable rubbing but produce a high luster.

Leather polish.—This contained the same materials as the furniture polish, but in different amounts.

Constituent.	Per cent.
Carnauba wax	7
Coconut-oil wax	4
Stearic acid	3
Triethanolamine	1
Turpentine	17
Water	68
Total	100

The stearic acid, triethanolamine, and water were mixed and heated until a uniform emulsion was obtained. The melted waxes containing turpentine were then added and the mixture stirred until rather cold.

The resulting product is cream-colored and suitable for polishing light-colored leathers. When treated with appropriate dyes this polish is suitable for dark-colored leathers.

When time permits, the chemistry of this waxy material, obtained from coconut oil, will be studied more in detail.

SUMMARY

During the storage of coconut oil a sediment gradually separates and is deposited on the bottom of the tank. When separated from foreign matter and purified this sediment is obtained as white crystals, which are soluble in various organic solvents.

Preliminary experiments showed that the purified coconut-oil residue does not yield glycerin as a decomposition product and is, therefore, not a glyceride. This residue would appear to be a wax containing the myricyl ester of cerotic acid.

Commercial products, such as floor wax and furniture and leather polishes, were prepared from this wax.

GLYCERINATED RINDERPEST VACCINE STORED AT ROOM TEMPERATURE [1]

By TEODULO TOPACIO

Of the Veterinary Research Division, Bureau of Animal Industry, Manila

Among the various types of wet rinderpest vaccine may be mentioned those of Kakizaki,(6, 7) Kakizaki et al.,(8) Boynton,(1) Kelser et al.,(9) Jacotot,(5) Curasson,(2) Curasson and Zylbertal,(3) and Evans(4) in which various chemicals were used as preservatives. The distemper vaccine of Laidlaw and Dunkin(10) and the fowl-plague vaccine of Todd(11) in a general way are prepared like the wet rinderpest vaccine. With the possible exception of Evans's rinderpest vaccine the others did not prove satisfactory in our hands when kept at local room temperature. Evans's, however, requires treatment for at least six to seven days before the product may be injected, which period corresponds to the time necessary to render the virus sufficiently attenuated or inert.

During the height of our campaign against rinderpest in the Philippine Islands some ten years ago, it was the experience that when mass vaccination was most urgently needed in order to halt the advance of an outbreak it was often difficult to provide the necessary quantity of vaccine at the desired moment. This was due mainly to the poor keeping qualities of the vaccine used then. The Boynton vaccine, for instance, requires from four to six weeks of storage before it can be tested. The Kelser vaccine, on the other hand, is ready for testing three days after preparation. Both vaccines, however, have the same disadvantage in that it is necessary to keep them on ice until they are injected; otherwise, they deteriorate quickly at room temperature. The vaccine to be described in this paper has all the advantages of rapid preparation and retains its protective power at room temperature for three months at least. Tests have not been made beyond this period.

[1] Bureau of Animal Industry Technical Bulletin 7. Received for publication May 6, 1935.

MATERIALS AND METHODS

The spleen and lymph glands of rinderpest animals were removed aseptically and treated in the manner employed in the preparation of the Kelser vaccine. The milled tissue pulp was strained without the addition of saline. The strained pulp was passed through a grinder of the type used for grinding corn for further trituration into much finer particles to the consistency of a soft paste. The concentration of tissue pulp was prepared in the proportion of 2 cc of tissue to 8 cc of 50 per cent glycerin-saline, 2.5 to 7.5, and 3 to 7 of the diluent, respectively. The mixture was shaken by hand in a bottle containing glass beads and infused in a Frigidaire at 0° to 5° C. for twenty-four hours. After the mixture had been strained through a double layer of gauze, formalin was added in a dilution of 1 to 1,000 by volume. It was next shaken in a motor-driven shaker for one to two hours and stored in a cool dark cabinet until ready for testing three days after preparation. Later, in the experiments, the shaking period was reduced from three to ten minutes daily for three successive days. Storage was maintained at room temperature throughout the testing periods (20 ° to 30 ° C.).

Safety tests.—Small-animal inoculations of the fourteen batches of vaccine proved satisfactory, no animal having shown undesirable effects. In cultural tests four lots were found to be completely sterile within a month. At no time was any dangerous contamination observed.

Potency tests.—Highly susceptible native cattle were employed for testing the potency of each lot of vaccine as in the case of the Kelser vaccine.

Dosage and route of inoculation.—Each lot was tested by injecting a single dose of 10 cc per animal intramuscularly in the muscle of the back behind the shoulder as in the method of administration of the Kelser vaccine. At the end of fourteen days 1 cc of whole virulent blood was given each test animal together with one or two susceptible animals as controls.

Concentration of tissue and storage.—In the lots of vaccine under consideration the first six lots contained 2 parts of tissue by volume to 8 parts of diluent. In lots 7 to 10 the proportion was 3 to 7, while in lots 11 to 14 it was 2.5 to 7.5. All the vaccines were kept at room temperature while they were being tested. The period of testing varied from three days to three months after preparation, during which time the vaccines were constantly kept at room temperature (20° to 30° C.).

TESTS OF FOURTEEN LOTS OF VACCINE

Vaccine 1.—Fuga animal 3101 received 10 cc of lot 9, seven days old, in the muscle of the back. No reaction followed the injection of a test dose of 1 cc virulent blood. Romblon animal 86 received the same amount of vaccine, one month old, and again no reaction followed the test injection of virulent blood. Fuga animal 3256 received a dose of the same material, three months old. The test injection of virus produced only a mild temperature reaction in this animal.

Vaccine 2.—This lot was prepared in the same manner as the preceding lot. Mindoro animal 108 was injected with 10 cc of the vaccine, nine days old, and Fuga animal 3274 received a similar dose of the vaccine, two months old. Both animals completely resisted a dose of 1 cc virulent blood with no reaction whatever, showing that they were fully protected.

Vaccine 3.—Fuga animal 3242 was inoculated with 10 cc of vaccine, three days old, and Fuga animal 3272 received the same dose of vaccine, one month old. The injection of 1 cc virulent blood caused only a thermal reaction without clinical symptoms.

Vaccine 4.—Fuga animal 3247 received 10 cc of vaccine, three days old, and Fuga animal 3414 was given the same amount of vaccine two months later. The first animal showed a thermal reaction to the test dose of 1 cc virulent blood, while the second developed rinderpest and was killed for rinderpest vaccine.

Vaccine 5.—Fuga animal 360 was injected with 10 cc of the vaccine, three days old, while Fuga animal 3412 received the same dose of the vaccine two months later. When both were given the test dose of virulent blood, the first showed a thermal reaction; the other developed rinderpest symptoms and was killed for vaccine.

Vaccine 6.—Fuga animal 383 received 10 cc of the vaccine, four days old, and Fuga animal 3418 received the same amount of the vaccine two months after preparation. The first animal showed no reaction to the virus test, while the other developed clinical rinderpest and was killed for vaccine.

Vaccine 7.—Three days after preparation this vaccine was injected into Fuga animal 402 in the standard dose. Fuga animal 3398 received the same vaccine when it was two months old. The first animal presented no reaction to the virus test, while the second showed a slight temperature reaction only, showing that both were immune.

Vaccine 8.—Fuga animal 3263 received a dose of vaccine three days old. Fuga animal 3406 was injected with the standard dose one month after preparation. After a test dose of virulent blood the first animal showed no signs of disease whatever, while the other presented a temperature response. This animal was originally in poor condition before it was given the injection.

Vaccine 9.—Fuga animal 403 received a dose of vaccine three days old, and Fuga animal 3410 a dose of the same material two months later. A test dose of virus produced no effect on the first animal, while the second animal developed rinderpest and was killed for vaccine.

Vaccine 10.—Fuga cattle 3251 and 3420 each received the standard dose of the vaccine three days and two months old, respectively. A test dose

of virulent blood a fortnight later produced a slight temperature reaction in the first animal and clinical rinderpest in the other, but the animal completely recovered.

Vaccine 11.—Fuga cattle 3417 and 3402 each received the standard dose of vaccine three days and one month old, respectively. The virulent blood injection gave no reaction to the first, and rinderpest symptoms in the other were followed by uneventful recovery.

Vaccine 12.—Fuga cattle 3423 and 3401 both were inoculated with the standard dose of the vaccine four days and one month, respectively, after its preparation. The test virus elicited no reaction in the first animal, while the second animal showed a temperature reaction. Both animals were completely protected.

Vaccine 13.—Fuga cattle 3261 and 3409 each received the standard dose of the vaccine three days and one month old, respectively. No reaction resulted after the test dose of the virulent blood, showing that a solid immunity was conferred upon both animals.

Vaccine 14.—Fuga cattle 3407 and 3411 were injected with 10 cc of the vaccine three days and one month old, respectively. At the end of fourteen days they were given the standard dose of virulent blood subcutaneously. The first animal presented no symptoms whatever, and the other responded by having a thermal reaction only.

The accompanying table summarizes in detail the tests made on the fourteen lots of vaccine just described:

TABLE 1.—*The tests of fourteen lots of vaccine and the results.*[a]

Animal No.	Vaccine No.	Concentration.	Age of vaccine.		Date injected.	Dose.	Virus (C.V.B.).[b]	Date injected.	Result.
			Mos.	*days*	1934	*cc.*	*cc.*	1934	
3101	1	2:8	0	7	Mar. 31	10	1	Apr. 13	No reaction.
86	1	2:8	1	0	Apr. 23	10	1	May 9	Do.
3256	1	2:8	3	0	June 29	10	1	July 13	Temperature reaction.
108	2	2:8	0	9	May 7	10	1	May 23	No reaction.
3274	2	2:8	2	0	July 7	10	1	July 20	Do.
3242	3	3:8	0	3	May 28	10	1	June 13	Temperature reaction.
3272	3	3:8	1	0	June 30	10	1	July 13	Do.
3247	4	3:8	0	3	June 12	10	1	June 27	Do.
3414	4	3:8	2	0	Aug. 9	10	1	Aug. 22	Killed for vaccine.
360	5	3:8	0	3	June 29	10	1	July 13	Temperature reaction.
3412	5	3:8	2	0	Aug. 16	10	1	Aug. 29	Killed for vaccine.

[a] Controls: Each vaccine test was accompanied by one or two controls, which developed typical rinderpest, and were killed for vaccine six days after virus inoculation without exception.

TABLE 1.—*The tests of fourteen lots of vaccine and the results*—Continued.

Animal No.	Vaccine No.	Concentration.	Age of vaccine.		Date injected.	Dose.	Virus (C.V.B.).[b]	Date injected.	Result.
			Mos.	*days*	1934	*cc.*	*cc.*	1934	
383	6	3:8	0	4	July 6	10	1	July 20	No reaction.
3418	6	3:8	2	0	Aug. 16	10	1	Aug. 29	Killed for vaccine.
402	7	3:7	0	3	July 11	10	1	July 25	No reaction.
3398	7	3:7	2	0	Sept. 9	10	1	Sept. 26	Slight temperature reaction.
3263	8	3:7	0	3	July 17	10	1	Aug. 1	No reaction.
3406	8	3:7	2	0	Sept. 17	10	1	Oct. 10	Temperature reaction (week animal?).
403	9	3:7	0	3	July 26	10	1	Aug. 8	No reaction.
3410	9	3:7	2	0	Sept. 26	10	1	Oct. 10	Killed for vaccine.
3251	10	3:7	0	5	Aug. 8	10	1	Aug. 22	Temperature reaction.
3420	10	3:7	1	24	Sept. 27	10	1	Oct. 10	Recovered.
3417	11	2.5:7.5	0	5	Aug. 16	10	1	Aug. 29	No reaction.
3402	11	2.5:7.5	1	0	Sept. 11	10	1	Sept. 26	Recovered.
3423	12	2.5:7.5	0	4	Aug. 16	10	1	Aug. 29	No reaction.
3401	12	2.5:7.5	1	0	Sept. 14	10	1	Oct. 3	Temperature reaction.
3261	13	2.5:7.5	0	3	Aug. 27	10	1	Sept. 12	No reaction.
3409	13	2.5:7.5	1	0	Sept. 22	10	1	Oct. 10	Do.
3407	14	2.5:7.5	0	3	Aug. 30	10	1	Sept. 19	Do.
3411	14	2.5:7.5	1	0	Sept. 27	10	1	Oct. 10	Temperature reaction.

[b] Concentrated whole virulent blood.

In the above table the résumé of results shows that of the twenty-nine animals employed in the tests only four, which developed severe rinderpest symptoms, were killed for vaccine. The total protection value of the vaccines was, therefore, 86.2 per cent.

DISCUSSION

Mention was made of the different wet vaccines prepared by contemporary workers on rinderpest. None of them had proven satisfactory at room temperature in our hands because their potency diminished rapidly, with the possible exception of Evans's vaccine, which according to his claim was still protective up to nineteen weeks after preparation when kept at tropical room temperature. However, his experiments were rather too limited to permit a safe deduction. Moreover, one week was

required before the vaccine could be completely attenuated for safe inoculation. With the glycerinated vaccine described in this paper attenuation is complete in three days, which is a decided advantage in its favor. The final result of testing the fourteen batches, summarized in Table 1, indicated that the vaccine was efficient as a satisfactory immunizing agent against rinderpest in the three concentrations employed. It is of particular interest to note that the concentration of tissue in vaccines 10 to 14 probably approached the ideal as far as potency was concerned, since all the test animals employed resisted successfully the test dose of virulent blood, giving a protection value of 100 per cent. Admittedly the number of lots of the vaccines tested is limited, but the results obtained were highly satisfactory with regard to potency and keeping qualities at room temperature.

The most notable feature about the vaccine in these experiments is the fact that in all the first tests of each lot solid immunity was conferred upon all the animals inoculated, so that it seems safe to assume that, at least within the first month after preparation, potency is almost absolute. Of fourteen animals used in the first test, four animals showed temperature reaction following the test dose of virulent blood. This variation, however, in antigenicity is regularly observed in tissue vaccines of this nature, because no two animals produce organ antigens of exactly the same titre. The same may be said of each separate brew of vaccine (for example, vaccines 4 and 5). This is unavoidable unless the antigenic index of the organs from each animal used for vaccine could be estimated beforehand by some reliable test whereby organs of high and low antigenic titres could be adjusted in proportionate amounts so as to permit standardization of potency of the final product. Under the circumstances, absolute standardization of antigenic unit is extremely difficult if not impossible, and results must be viewed in a relative sense in consonance with the varying capacity of each animal to develop antigenic principles in its organs utilized for making the vaccine.

SUMMARY

1. A glycerinated rinderpest vaccine capable of storage at local room temperature is described.

2. The vaccine is of high immunizing value as shown by the fact that 86.2 per cent of all the animals vaccinated resisted successfully the test dose of virulent blood.

3. The chief advantage of this vaccine lies in the rapidity of its preparation and its keeping quality at local room temperature (20° to 30° C.).

4. There is evidence that with better care in technic this vaccine can be rendered bacteria-free one month after preparation, since in four series it was found to be sterile within this period even with the ordinary aseptic methods of handling the materials.

ACKNOWLEDGMENT

Thanks are due to Dr. V. Buencamino and Dr. Gregorio San Agustin, director and assistant director of the Bureau of Animal Industry, respectively, for their unfailing support in research work, and to Dr. Anacleto B. Coronel for technical assistance in carrying out the experiments.

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THE PASTEUR ANTIRABIC TREATMENT AT THE BUREAU OF SCIENCE, MANILA

By ANA VAZQUEZ-COLET

Of the Division of Biological Products, Bureau of Science, Manila

The object of this paper is to report the results of the Pasteur treatment as carried out at the Bureau of Science, Manila, Philippine Islands. The report includes all the cases treated since the institution of antirabic treatment in the Philippines nineteen years ago; that is, from April 23, 1914, to December 31, 1933.

TYPES OF VACCINE EMPLOYED

On the first page of the book used for recording the cases reporting for Pasteur treatment, Dr. E. W. Ruediger, who initiated the prophylactic treatment of rabies in the Philippines, wrote the following information: "The strain of rabies vaccine (fixed virus of rabies) was obtained from the Pasteur Institute in Saigon. The method of application is a slight modification of that described by Otto Lentz, Deutsche medizinische Wochenschrift, (1910), 36, 1257." The same strain is being used at the present time. From 1914 to 1927, inclusive, the vaccine employed was prepared from 3-day cords that were ground up and emulsified in 0.5 per cent phenolized physiologic salt solution and diluted in such a way that 0.5 cc of the emulsion represented a certain length of the cord; namely, 0.25 to 0.5 cm. After that time a 1 per cent emulsion of fresh rabid brains and cord in carbolized salt solution has been used. In both cases the method of administration was the same, the following doses being employed for adults:

Day.	cc.	Day.	cc.
First	0.5	Fourteenth	1.0
Second	1.0	Fifteenth	1.5
Third	1.5	Sixteenth	1.0
Fourth	0.5	Seventeenth	1.5
Fifth	1.0	Eighteenth	1.0
Sixth	1.5	Nineteenth	1.5
Seventh	0.5	Twentieth	1.0
Eighth	1.0	Twenty-first	1.5
Ninth	1.5	Twenty-second	1.5
Tenth	0.5	Twenty-third	1.0
Eleventh	1.0	Twenty-fourth	1.5
Twelfth	1.5	Twenty-fifth	1.5
Thirteenth	0.5		

To children under 5 years of age one-half of the adult dose and to children from 5 to 10 years three-fourths of the adult dose was given. Twenty-five injections constitute a complete course of Pasteur treatment.

RESULTS OF TREATMENT

From April 23, 1914, to December 31, 1933, inclusive, the total number of cases treated was 17,858, of which 11,345, or 63.53 per cent, were males, and 6,513, or 36.47 per cent, females. Nine thousand three hundred thirty-nine (9,339) cases, or 52.30 per cent, received complete treatment, and 8,519 cases, or 47.70 per cent, incomplete treatment. Of all the cases 17,609, or 98.61 per cent, were bitten by dogs, and the remaining, less than 2 per cent, by other animals. Of the total number of cases 16,682 were Filipinos, 975 Europeans and Americans, 112 Chinese, 83 Japanese, 5 Hindus, and 1 Negro. The deaths recorded resulted from dog bites and occurred only among Filipinos, this death rate being 0.0243 per cent, or 4 deaths, among the 16,459 Filipinos bitten by dogs. In computing the death rate, only the hydrophobia cases that took complete treatment and died later than fifteen days after the completion of the treatment have been considered. If the computation is based only on the number of those cases (8,150) that received complete treatment for dog bites, Filipinos only being considered, the death rate would be a little higher; namely, 0.049 per cent. Taking all the cases of dog bites among Filipinos—namely, 16,459, regardless of the kind of treatment received—there were in all 14 deaths, or a death rate of 0.085 per cent. Of these 14 cases, 11, or 78.57 per cent, were males and 3, or 21.43 per cent, were females.[1]

PROBABILITY OF RABIES IN THE BITING ANIMAL

The biting animals have been classified into four categories; namely, A, not suspected of rabies; B, suspected of rabies; C, proved rabid; D, certified rabid.

Category A includes all those cases in which the condition of the biting animal was apparently normal. In group B are included all cases in which, according to popular observation, the

[1] "In accordance with the resolution of the International Rabies Conference, all deaths, whether occurring during treatment or after its termination, are to be included in the schedules." League of Nations Quarterly Bulletin of the Health Organization 2 No. 4 (December, 1933). A. G. McKendrick. See Tables 1 to 4.

biting animal was rabid. In this connection it may be stated that many people in the Philippines are well acquainted with the symptoms of rabies in dogs. In category C are placed those animals in the brains of which Negri bodies were found. In category D the animals were certified rabid by competent veterinarians.

The biting animals in 75 per cent of those cases that developed hydrophobia later than fifteen days after the completion of treatment belonged to category B (suspected of rabies) and in 25 per cent to category A (not suspected of rabies). All of the cases that developed hydrophobia within fifteen days after the completion of treatment were bitten by animals belonging to category B (suspected of rabies). In two-thirds of the cases developing hydrophobia during treatment, the biting animals belonged to category A (not suspected of rabies). This is an observation worth emphasizing, as it shows how dangerous it is to forego Pasteur treatment in cases in which the biting animal is apparently normal. In the remaining one-third of the cases the biting animals belonged to category B (suspected of rabies). In those cases that received only a few injections (3 to 12 injections) and developed hydrophobia afterwards, the biting animal in two-thirds of such cases belonged to category B (suspected of rabies), while in the remaining one-third the biting animals belonged to category A (not suspected of rabies). Of the cases that developed hydrophobia, irrespective of whether treatment was complete or incomplete, 57.14 per cent were bitten by dogs belonging to category B (suspected of rabies) and 42.86 per cent by dogs belonging to category A (not suspected of rabies). No deaths from hydrophobia occurred in persons bitten by animals belonging to groups C (proved rabid) and D (certified rabid). This was probably due to the fact that the individuals concerned were advised by veterinarians to take early and complete Pasteur treatment.

INCUBATION PERIOD

Of the fourteen cases that developed hydrophobia 14.28 per cent came down with symptoms of the disease within the first month; that is, on the thirteenth and twentieth day after the bite; in 50 per cent of the cases rabies showed itself within two months, in 85.71 per cent within three months, and in 7.14 per cent within four to six months. Striking an average for all the cases, the incubation period was fifty-four days (Tables 1 to 4).

TABLE 1.—*Cases developing hydrophobia later than fifteen days after completion of treatment (failures).*

Year.	Case No.	Serial No.	Sex.	Age.	Animal.	Bite site.	Days late.	Injections.	Incubation period.
				Yrs.					*Days.*
1920	1607	1	Male	5	Dog (suspected of rabies).	Trunk	46	25 (from April 9 to May 14, somewhat irregular).	164
1925	4840	2	Female	55	do	Foot	0	25 (daily)	58
1929	8932	3	do	43	do	do	0	do	67
1930	1165	4	Male	12	Dog (not suspected of rabies).	Arm (arm and chest)	0	23 (daily)	107

TABLE 2.—*Case developing hydrophobia within fifteen days of completion of treatment.*

Year	1926
Case No.	6232
Serial No.	1
Sex	Male.
Age, years,	21
Animal	Dog (suspected of rabies).
Bite site	Arm (arm and chest).
Days late	5
Incubation period, days,	41
Total daily injections	25

TABLE 3.—*Cases developing hydrophobia during treatment.*

Year.	Case No.	Serial No.	Sex.	Age.	Animal.	Bite site.	Days late.	Injections.	Incubation period.
				Yrs.					*Days.*
1919	1475	1	Male	14	Dog (suspected of rabies).	Head (face).	2	11	13
1928	8537	2	do	5	Dog (not suspected of rabies).	Arm (deep lacerated wound on upper arm).	2	14	20
1931	12759	3	Female	5	do	Arm	2	[a] 7	32

[a] July 24, August 18, 19, 20, 21, 22 last injection double dose.

TABLE 4.—*Cases that took only a few antirabic injections and then quit and later developed hydrophobia.*

Year.	Case No.	Serial No.	Sex.	Age.	Animal.	Bite site.	Days late.	Incubation period.	Injections.
				Yrs.				*Days.*	
1919	1379	1	Male.......	19	Dog (suspected of rabies).	(?)	2	60	3
1922	2759	2	.....do.....	12	.....do.......	Arm (arms)..	3	30	12
1922	3253	3	.....do.....	21	.....do.......	Head (face and head).	3	46	8
1926	556	4	.....do.....	6	Dog (not suspected of rabies).	Head (face)...	0	50	6
1928	8503	5	.....do.....	6	Dog (suspected of rabies).	Head (face and arm).	1	55	8
1929	9557	6	.....do.....	4	Dog (not suspected of rabies).	Head (face, head, trunk)	2	77	4

LATENESS OF ARRIVAL FOR TREATMENT

It may be noted that the longest incubation period, which is one hundred sixty-four days, among our cases of hydrophobia was observed in a patient who reported for Pasteur treatment forty-six days after being bitten by a dog that was suspected of rabies (case 1607, serial case No. 1, Table 1). If in the group of persons that received complete treatment (Table 1) only the three cases that came for Pasteur treatment within the first twenty-four hours after the bite are considered, the average incubation period for such cases would be seventy-four days, which is even shorter than the incubation period of seventy-seven days observed in case 9557, Serial No. 6, Table 4, who reported two days after having been bitten by a dog not suspected of rabies and who received only four antirabic injections. Although it is realized that there exist differences in the virulence of street virus as well as in the degrees of susceptibility and resistance of individuals, the results, as pointed out above, are rather disconcerting. However, the hydrophobia cases here considered are too few to justify any conclusion.

LOCATION OF BITES

The classification recommended by the Paris Conference on Rabies under the auspices of the League of Nations has been followed in describing the location of the bites.

"Head," "Arm," "Trunk," and "Leg" indicate bites on these parts, multiple bites having been classed according to the site of greatest danger. "Unknown" means that the site of the bite was not mentioned in the case records. Considering only the fourteen cases of the series that developed hydrophobia, the locations of the bites were as follows:

	Per cent.
Head	35.714
Arm	35.714
Trunk	7.143
Leg	14.286
Unknown	7.143

Considering the total number of cases treated, the bite sites were as follows:

	Per cent.
Head	7.46
Arm	29.69
Trunk	7.71
Leg	52.06
Unknown	1.61
Contacts	1.47

AGE OF THE PATIENTS

Of the fourteen cases that developed hydrophobia, six, or 42.85 per cent, were under 9 years of age; four, or 28.57 per cent, were between 10 and 19 years of age; two, or 14.29 per cent, ranged from 20 to 30 years; and two, or 14.29 per cent, were above 30 years of age.

UNTOWARD EFFECTS OF TREATMENT

Paralytic accidents.—Postvaccination paralysis has never been observed among our cases. In this connection the following observations may be recorded. By inoculating a series of rabbits intradurally with emulsions of one-day, two-day, and three-day cords obtained from rabid rabbits that had been inoculated with fixed virus, it was observed that the one- and two-day cords sometimes produced rabies in the inoculated rabbits, whereas the three-day cords never produced the disease in the inoculated animals. This probably explains the absence of postvaccination paralysis in our cases treated according to the method of Pasteur but using only three-day cords, as observed elsewhere in this paper. With the dilute carbolized vaccine, which has been used at the Bureau of Science since 1928, the dilution and the phenolization of the vaccine probably so alter the virus that it is rendered incapable of producing paralysis.

Anaphylactic manifestations.—The majority of the cases had no complaints to make. Children as young as 1.5 months old and people as old as 110 years have taken the treatment without showing any ill effects. There were two young women, however, who, a few minutes after receiving the first injection experienced great prostration and general malaise. The symptoms, however, disappeared rapidly and never recurred during the course of the treatment. Two other cases developed urticaria following the first injection, and both refused to have the treatment continued because in their opinion it was the cause of the urticaria. On the other hand, several of the cases here reported received complete Pasteur treatment on as many as three different occasions and did not manifest the least sign of anaphylaxis. In a few instances, especially in children, the patients gained in weight and improved in general health during the course of the treatment.

Other manifestations.—A few of the patients experienced general malaise during the entire course of the treatment. The examination of the urine of these cases revealed the presence of albumin and tube casts.

COMPARISON OF METHODS OF TREATMENT EMPLOYED

From 1914 to the end of 1927, the vaccine used for Pasteur treatment was prepared from three-day cords. During this period there were treated 6,266 cases bitten by dogs, of which 5,716 were Filipinos, and 8 of them (Filipinos) developed hydrophobia. Only 3,450 of the Filipinos bitten by dogs took complete treatment, and of the 8 that developed hydrophobia only 3 took complete treatment, giving a death rate of 0.08 per cent.

From 1928 to 1933 carbolized vaccine was used. During this period there were treated 11,343 cases bitten by dogs, of which 10,743 were Filipinos and 6 of them (Filipinos) developed rabies. Only 4,700 of the Filipinos bitten by dogs took complete treatment, and of the 6 cases that developed hydrophobia only 2 received complete treatment, giving a death rate of 0.04 per cent. The figures show that with the use of the dried cord the incidence of hydrophobia was twice as great as with the use of carbolized rabid brain emulsion.

SUMMARY

The total number of cases given Pasteur treatment at the Bureau of Science from 1914 to 1933, a period of nineteen years, is 17,858. Of these 52.30 per cent were males and 47.70 per

cent females. Classified according to age, 35.42 per cent of the patients were children up to 9 years of age; 29.50 per cent were from 10 to 19 years; 16.58 per cent were 20 to 30 years; and 18.50 per cent were above 30 years of age.

In 94.90 per cent of the cases the implicated animals were not suspected of rabies; in 4.10 per cent they were suspected of rabies; in 0.55 per cent they were proved rabid; and in 0.45 per cent they were certified rabid.

In 7.46 per cent of the cases the bites were inflicted on the head, in 29.69 per cent on the arm, in 7.71 per cent on the trunk, in 52.06 per cent on the leg, and in 1.61 per cent of the cases the site of the bite was not specified. The rest of the cases (1.47 per cent) were contacts only; that is, they were not actually bitten, but they only came in contact with, or were licked by, the implicated animals.

In 98.61 per cent of the cases the implicated animals were dogs, the rest (1.39 per cent) included cats, monkeys, horses, pigs, rats, rabbits, and human beings.

Of the total number of patients 18.51 per cent reported within the first twenty-four hours after being bitten, 56.38 per cent in from one to two days, and 25.11 per cent later than three days after the infliction of the bite.

Patients coming to the Bureau of Science for Pasteur treatment are adviced to report daily until they have received the complete treatment of twenty-five injections of rabies vaccine. In spite of this, however, the records show that 52.30 per cent of the cases took the complete treatment, the remaining 47.70 per cent receiving only from one to fourteen injections.

The percentage of mortality was 0.049 per cent. In computing the mortality only those cases that took complete treatment and died later than fifteen days after completion of the treatment have been considered.

An analysis of the incubation period in the cases that developed hydrophobia later than fifteen days after the completion of the treatment has failed to indicate any tendency for the mortality to increase with lateness of arrival for treatment. Neither does the site of the bite seem to have influenced the length of the incubation period.

A comparison of the efficiency of the two types of vaccine employed brings out the fact that with the use of the three-day cord the incidence of hydrophobia among the cases was twice as great as with the use of the carbolized vaccine.

TWO MORE NEW HETEROPHYID TREMATODES FROM THE PHILIPPINES

By CANDIDO M. AFRICA and E. Y. GARCIA

*Of the School of Hygiene and Public Health, University of the Philippines
Manila*

ONE PLATE

In a previous paper, which is still in press, we have described three new species of flukes of the family Heterophyidæ Odhner, 1914, two from dog and one from man and reported the occurrence of several hitherto unknown members of this group in these two hosts in the Philippines. On extending our investigation further, we found two more new species of this group representing two genera; namely, *Monorchotrema* Nishigori, 1924, and *Apophallus* Lühe, 1909. For the first trematode the name *Monorchotrema calderoni* is proposed in honor of Prof. Fernando Calderon, dean of the College of Medicine and director of the School of Hygiene and Public Health, University of the Philippines, and for the second the name *Apophallus eccentricus* is proposed on account of the eccentric position of the genital pore.

MONORCHOTREMA CALDERONI sp. nov. Plate 1, fig. 1.

The following description is based on the study of a considerable number of the 137 specimens of this fluke obtained from dogs on four occasions in parasitic association with *Heterophyes expectans* Africa and Garcia (1935), *Monorchotrema taichui* Nishigori, 1924, and *Apophallus eccentricus,* a new species herein described. In this connection we might mention that we encountered previously in autopsies of man and dog both *Monorchotrema taichui* and *Monorchotrema taihokui.*

Body very small, 0.47 to 0.48 mm by 0.25 to 0.26 mm, pear-shaped, covered with scalelike spines. Oral sucker subterminal, 0.05 mm in diameter; acetabulum absent; prepharynx short; pharynx globular, 0.03 mm in diameter; œsophagus long and capillary; intestinal cæca simple tubes running close to the sides of the fluke and extending to near the posterior end of the body.

Female organs.—Ovary globular, 0.055 to 0.057 mm in diameter, close to the median line, between the genital sac and the testis but closer to the former; receptaculum seminis large, globular, 0.103 by 0.073 mm, situated on the left side of the body between the testes and the ovary; the oviduct runs posteriorly from the ovary to meet the short duct from the receptaculum seminis and the descending stem of the uterus in the median line; the uterus descends at the right side and after making several loops in the posterior half of the body, ascends at the left side along the left cæcum towards the genital sac where it ends in common with the ejaculatory duct into the genital pore; the vitellaria are composed of large isolated follicles with median distribution in front of the testis.

Male organs.—The single large spherical testis, 0.225 mm in diameter, occupies the median field of the posterior third of the body; the seminal vesicle situated opposite to the receptaculum seminis, consists of two very unequal parts, the first a small globular sac separated from the larger, very much longer anterior or expulsor portion, by a short constriction. The anterior or expulsor portion is an enormous cucumberlike cylindrical organ, 0.23 by 0.035 mm, which runs posteroanteriorly along the inner curvature of the right cæcum towards the genital sac, which in 80 per cent of the specimens, is located in the median line almost immediately behind the bifurcation of the œsophagus. The gonotyl, which is provided with an incomplete circlet of very minute spines, completely fills the genital sac.

The excretory bladder is Y-shaped.

Eggs, 0.021 to 0.022 mm by 0.011 to 0.012 mm.

Specific diagnosis.—*Monorchotrema:* Body small, 0.47 to 0.48 mm by 0.25 to 0.26 mm, pear-shaped, covered with scalelike spines; prepharynx short; œsophagus long and capillary; oral sucker subterminal, 0.05 mm; ventral sucker absent; single testis (0.225 mm in diameter) at posterior end of body; ovary in front of testis; seminal receptacle between testis and ovary; seminal vesicle consists of two very unequal portions, the anterior or expulsor portion powerfully developed, very prominent and cucumberlike in shape; vitellaria lie at posterior part of the body, mostly median; uterus coils at sides of testis and in front of it; genital sac as a rule in median line, close behind the bifurcation of the œsophagus, containing a large gonotyl which bears an incomplete circlet of very fine spines; excretory vesicle Y-shaped; eggs 0.021 to 0.022 mm by 0.011 to 0.012 mm.

Host.—Dog.

Location.—Small intestine.

Locality.—Biñan, Laguna Province, Luzon.

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Hitherto four species of the genus *Monorchotrema* Nishigori, 1924, have been described; namely, *Monorchotrema taichui* Nishigori, 1924, *M. taihokui* Nishigori, 1924, *M. microrchia* Katsuta, 1932, and *M. yokogawai* Katsuta, 1932. *Monorchotrema calderoni* is more closely related to *M. microrchia* than to any other member of the genus. However, it differs from the latter in the following points: (1) The body of *Monorchotrema calderoni* is distinctly pear-shaped, while in *M. microrchia* it is elongate, (2) the genital sac of *M. calderoni* is close to, or immediately behind, the bifurcation of the œsophagus and median in position in the majority of specimens, while in *M. microrchia* it is farther down from the œsophageal bifurcation and eccentrically placed, (3) the expulsor portion of the seminal vesicle in *M. calderoni* is cucumber-shaped, very prominent and enormously long, while in *M. microrchia* the expulsor is short, saclike, and not as prominent.

APOPHALLUS ECCENTRICUS sp. nov. Plate 1, fig. 2.

Body elongated, 2.15 by 0.35 mm, greatest width at the level of the testes; cuticle covered with scalelike spines. Oral sucker subterminal, 0.09 mm in diameter; prepharynx longer than œsophagus; pharynx squarish, 0.05 by 0.05 mm with biconcave sides; bifurcation of œsophagus closer to the ventral sucker than to the oral sucker; intestines slender, extending to near the posterior end of the body. Acetabulum 0.055 mm in diameter, preëquatorial at the junction of the anterior and middle thirds of the body, and opening into the genital sinus. Genital pore at the left lateral end of the genital sinus, the aperture being guarded by two crescentic papillalike gonotyls, 0.03 by 0.012 mm.

Female organs.—Ovary globular, 0.12 mm in diameter, on right side of the body about midway between acetabulum and anterior testis; behind it is the ovoid receptaculum seminis, 0.09 by 0.06 mm. The uterine coils are not confined to the intercæcal space, but liberally spread between the acetabulum and the most posterior end of the body. The vitellaria are composed of large follicles, confluent posteriorly but not anteriorly, extending from the posterior end to the level of the ovary, never beyond.

Male organs.—Testes roughly globular, placed obliquely one behind the other, considerably removed from the posterior end of the body, the anterior or left testis usually the smaller, 0.25 by 0.2 mm, the posterior one 0.3 by 0.29 mm. The seminal vesicle consists of several portions, which form an S-shaped organ directly behind the acetabulum, except the expulsor portion which swerves to the left side to join the vagina before opening into the genital pore.

Eggs, 0.022 by 0.012 mm.

Specific diagnosis.—*Apophallus:* Body elongated, 2.5 by 0.35 mm, greatest width at the level of the testes; cuticle covered with scalelike spines; prepharynx longer than œsophagus; intestinal bifurcation closer to acetabulum than to oral sucker; intestines slender, extending to near posterior end of body, acetabulum preequatorial at junction of anterior and middle thirds of body and opening into genital sinus; genital pore eccentrically located at left lateral end of genital sinus on same level with acetabulum, and guarded by two crescentic papillalike gonotyls; ovary globular, 0.120 mm in diameter, on right side of body about midway between acetabulum and anterior testis; uterine coils not confined to the intracæcal space and liberally spread between acetabulum and posterior end of body; vitellaria composed of large follicles, confluent posteriorly but not anteriorly, never extending beyond the ovary anteriorly; testes roughly globular, obliquely one behind the other, considerably removed from the posterior end of body, the right or posterior testis being the larger, 0.3 by 0.29 mm, the left or anterior testis, 0.25 by 0.2 mm, the seminal vesicle composed of several portions separated by constrictions having an S-shaped organ directly behind the acetabulum.

Host.—Dog.

Location.—Small intestine.

Locality.—Biñan, Laguna Province, Luzon.

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—The species that have been assigned to the genus *Apophallus* by previous writers are as follows: *Apophallus muhlingi* (Jägerskiöld, 1899) Lühe, 1909 (type of genus); *A. brevis* Ransom, 1920; *A. major* Szidat, 1924; and *A. crami* Price, 1931. According to Witenberg (1929), *A. major* is a synonym of *A. muhlingi*, and *A. brevis* a synonym of *Rossicotrema donicum* Skrjabin, 1919. Price (1931), on the other hand, claims that

A. brevis should be regarded as a distinct species, at least until more material is available for study, and opines further that it stands closer to *A. muhlingi* than to *R. donicum*. *Apophallus eccentricus* differs from either *A. muhlingi* or *A. crami* principally in the following points:

1. In *A. eccentricus* the prepharynx is longer than the œsophagus, while in both *A. muhlingi* and *A. crami* the œsophagus is several times longer than the prepharynx.
2. In *A. eccentricus* the genital pore is on the left lateral end of the genital sac, while in both *A. muhlingi* and *A. crami* this organ is at the anterior end.
3. In *A. eccentricus* the ventrogenital apparatus is situated a considerable distance anteriorly to the middle of the body, or at the junction of the anterior and middle thirds of the body, while in both *A. muhlingi* and *A. crami* it is situated at the equator.
4. In *A. eccentricus* the vitellaria never extend beyond the ovary anteriorly, while in *A. muhlingi* the vitellaria extend anteriorly as far as the acetabulum and in *A. crami* they extend anteriorly to a point about midway between the acetabulum and the ovary.
5. The eggs of *A. eccentricus* measure about 0.022 by 0.012 mm, while they measure about 0.032 by 0.018 mm in *A. muhlingi* and 0.033 by 0.025 mm in *A. crami*.

SUMMARY

Two new species of Heterophyidæ Odhner, 1914; namely, *Apophallus eccentricus* and *Monorchotrema calderoni*, are described from the small intestine of Philippine dogs.

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ILLUSTRATION

PLATE 1

FIG. 1. *Monorchotrema calderoni* sp. nov.
2. *Apophallus eccentricus* sp. nov.

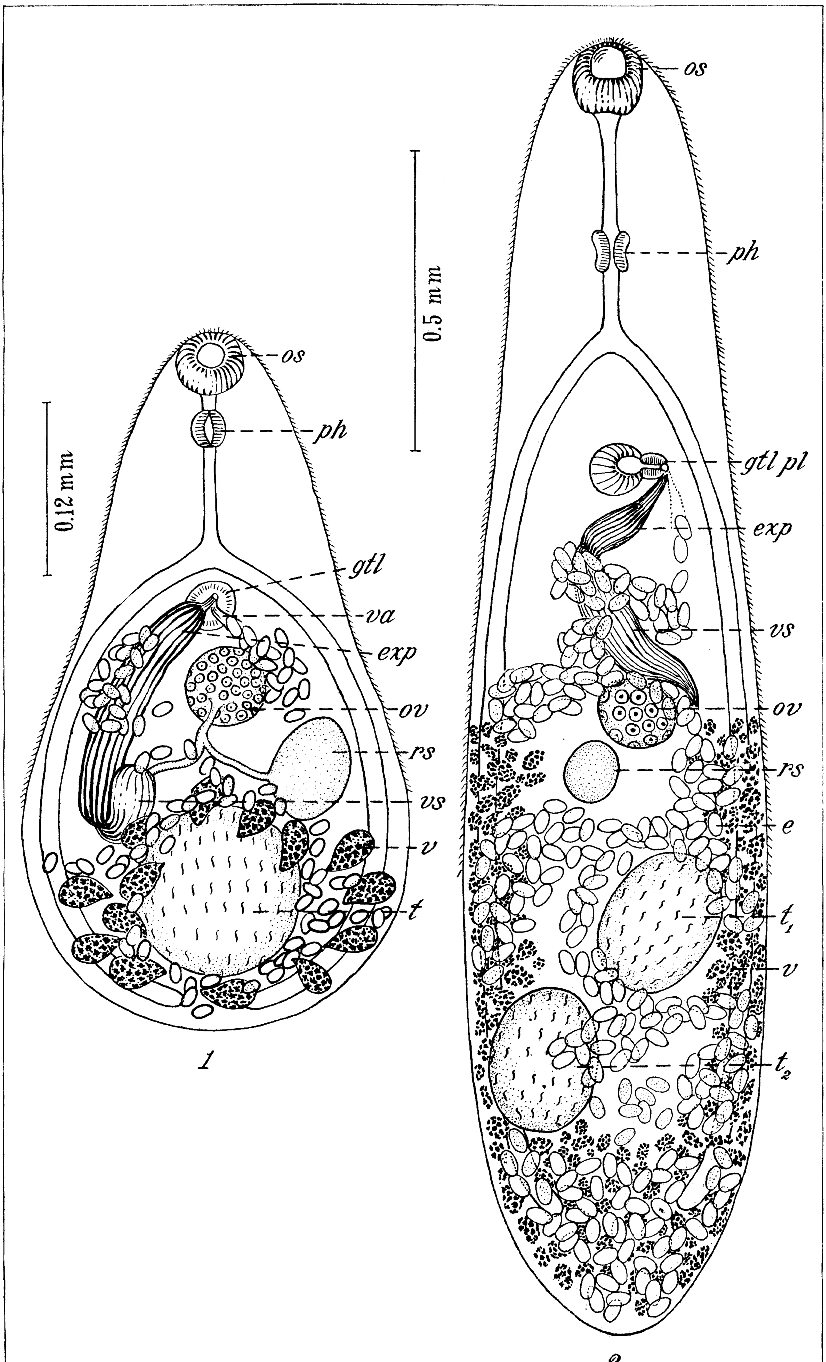

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PLATE 1.

DIPHYLLOBOTHRIUM LATUM (LINNÆUS, 1758) LÜHE, 1910, IN A NATIVE FILIPINO

By E. Y. Garcia and C. M. Africa

Of the School of Hygiene and Public Health, University of the Philippines Manila

ONE PLATE

Garrison (1907), after making fæcal examinations of about 4,000 Bilibid prisoners, mentioned the probability of finding *Diphyllobothrium latum* in man and in domestic animals in the Philippines in the future. He based this opinion on the geographic relations of this country to China and Japan where this tapeworm is endemic, and on the important rôle that fish play in the diet of the Filipinos. Crowell and Hammack (1913) reported many helminths encountered in 500 human autopsies, but evidently they failed to find any diphyllobothrid. Wharton (1917), however, reported the occurrence of *Diphyllobothrium* sp. in the intestine of 5 per cent of 118 dogs autopsied in the City of Manila. Tubangui (1925) listed *Diphyllobothrium mansoni* Cobbold, 1882, among the tapeworms occurring in dogs and cats in this country; so the diphyllobothrid that Wharton reported from dogs probably belongs to this species. Schwartz and Tubangui (1922) also failed to detect *Diphyllobothrium* infestation in the fæces of 500 students of the University of the Philippines from nearly all provinces of the country, although they encountered several cyclophyllidean infestations; such as, *Tænia, Hymenolepis, Dipylidium,* etc. Since then various other similar surveys have been made, but *Diphyllobothrium* infestation was conspicuous by its absence. The recent discovery, therefore, of a *Diphyllobothrium* infestation in a Filipino child who has never been out of the Islands, which appears to involve the well-known *Diphyllobothrium latum,* excited no little interest, as it tends to define a new area in the geographic distribution of this important tapeworm, and suggests the possibility of its recent introduction from foreign endemic areas.

CASE REPORT

F. B., a 7-year-old Filipino boy, born and residing in Biñang, Laguna Province, Luzon, complained of marked pallor, slight puffiness of the eyelids, and slight œdema of the lower extremities. Illness about five months in duration, according to the mother. First noticed as slight pallor of the lips and cheeks, the anæmia developing progressively until the child began to have in the course of three months after the onset, frequent attacks of palpitation, chest oppression accompanied by nausea and slight dizziness. Later the child developed bleeding gums, and œdema of the extremities and occasional epistaxis. Treated by various physicians as a case of chronic nephritis. Eventually came to the senior author and the case was treated as one of severe anæmia, secondary to hookworm disease with the following physical findings: Marked pallor, puffy eyelids, slightly œdematous lower extremities, swollen and congested gums, dyspneic breathing, sibilant râles over both bases of lungs, enlarged area of cardiac dullness and soft systolic murmur over the pulmonic area, which is transmitted to the mitral area; abdomen slightly bulging without evidence of fluid. Condition rapidly developed from bad to worse, and the child died about five months after the onset of illness. Immediately after death several chains of segments of what appeared to be a diphyllobothrid tapeworm were recovered by the mother and presented to the senior author. It was not till after this happening that it dawned upon the mind of the senior author that he had been dealing with a case of *Diphyllobothrium* infestation, and fully realized his misdiagnosis of a typical case of *Diphyllobothrium latum* anæmia due to the deep-rooted conviction that such infestation was absent in the Philippines.

DESCRIPTION OF THE WORM

The mature segments in fresh state average 1.5 mm long by 9.5 mm broad; while the gravid segments average 1.8 mm long by 10 mm broad. The testes are small, multiple, spherical bodies situated in the lateral fields near the dorsal surface of the segment. They are drained by several vasa efferentia which converge towards the median line to form one common duct, the ductus deferens. This duct proceeds anteriad as a convoluted tubule and ends in a muscular cirral organ, which opens on the anterior aspect of the common genital pore. The ovary is a somewhat symmetrical bilobed structure situated near

the ventral surface in the posterior fourth of the segment. In the median line between these two lobes is the shell-gland complex, which is connected at its anterior aspect with the common duct formed by the union of the two oviducts and posterior end of the vagina. From this union the vagina proceeds anteriad describing two or three coils and opening on the posterior aspect of the common genital pore. In the lateral fields ventral to the testes are the vitelline glands, the ducts of which converge to form the right and left main ducts, which in turn fuse into a common vitelline duct. The uterus arises from the left anterior aspect of the oötype, twists back and forth from side to side, and finally terminates in a uterine pore situated in the median line a short distance posterior to the common genital pore. The number of coils on each side varies from three to five depending on the number of eggs to be accommodated. These coils are disposed in a rosette formation in gravid segments. The eggs are operculated, have the characteristic somewhat rounded abopercular end, and measure 0.069 mm by 0.045 mm.

Judging from the foregoing description of this diphyllobothrid and the characteristic symptoms of *Diphyllobothrium* anæmia with which it has been associated, it is evident that we are dealing with an infestation of *Diphyllobothrium latum.*

DISCUSSION

The fact that *Diphyllobothrium latum* has not been encountered previously among native Filipinos despite years of active helminthologic surveys and thousands of autopsies performed both in Manila and other regions of the Archipelago, suggests either (*a*) that it is of recent introduction from some foreign endemic focus, or (*b*) that it has long been endemic in this country, but occurs in such a small percentage of the population that it has remained undetected until the present time. That the habit of eating raw fish is not popular among Filipinos can hardly be offered as a reason for its rare occurrence here, since recently the present authors (Africa and Garcia, 1935) discovered several heterophyids—such as, *Monorchotrema taichui, Monorchotrema taihokui, Diorchitrema pseudocirrata,* and a hitherto undescribed species of the genus *Heterophyes*—among natives, infestations that are known to be contracted through eating various forms of raw fish. Furthermore, had this diphyllobothrid been endemic here for some time, autopsies of dogs and cats would have yielded this tapeworm in the past, as has

been the experience wherever this tapeworm is endemic. The first possibility, therefore, is held the more likely considering the following circumstancial evidence: (*a*) This infestation first appeared in this country in one of the towns located on the shore of Laguna de Bay, a fresh-water lake into which *Cyprinus carpio* of the Family Cyprinidæ, which includes the vertebrate intermediate hosts of this diphyllobothrid in China, was introduced successfully eight years ago from the latter country; (*b*) Chinese and Japanese immigrants have settled right along the shore of this lake, in fact the junior author has been witness to the fact that in one of the Japanese restaurants located in one of the towns bordering the lake, the closet is built right over the water line; (*c*) this lake is rich in *Cyclops* and *Diaptomus*, and considering that *Diphyllobothrium latum* lacks specificity in its choice of a crustacean intermediate host, it would seem that the recent introduction of *Cyprinus carpio* into this locality supplied what had been long missing in the past for the successful introduction of this tapeworm into this region. Otherwise, this diphyllobothrid would have appeared a long time ago in the Philippines, since Chinese and Japanese have been coming to this country from time immemorial.

This is not the first instance wherein the spread of this infestation to a new area has been noted. There is also ample evidence, although direct proofs are lacking, that *D. latum*, which is found frequently infesting the inhabitants of the states bordering the Great Lakes of North America, was taken to that new area by immigrants from countries bordering the Baltic Sea.

That diphyllobothrids lack specificity in their choice of crustacean intermediate hosts is shown by the experience of Li (1929) with *Diphyllobothrium decipiens* and *D. erinacei* whose procercoid can develop in almost any species of *Cyclops*. In the Philippines Africa (1933) successfully infected *Cyclops serrulatus* Fischer and *C. bicolor* Sars with coracidia of *Diphyllobothrium mansoni*. The researches of Janicki and Rosen (1917) and Essex (1927) (cited by Faust et al., 1929) have incriminated *Cyclops strenuus*, *C. brevispinosus*, *C. prasinus*, *Diaptomus gracilis*, and *D. oregonensis* as first intermediate hosts of *Diphyllobothrium latum*. As the Philippines is very rich in fresh-water crustaceans, there seems to be no reason why *D. latum* cannot gain a permanent foothold in this country provided the right species of fish are present. Again, in this respect *D. latum* exhibits a remarkable range in its choice of a piscine host. In

Europe it is either the pike (*Esox lucius*), the perch (*Perca fluviatilis*), the miller's thumb (*Lota vulgaris*), the salmon (*Salmo umbla*), the trout (*Trutta vulgaris*), the lake trout (*T. locustris*), or the grayling (*Thymallus vulgaris*); in North America it is either the northern pike (*Esox lucius*), the wall eye (*Stizosctedium vitreum*), the sand pike (*S. canadense griseum*), or the turbot (*Lota maculosa*); in Japan it is the rainbow trout (*Onchorhynchus perryi*); in China it is *Barbus vulgaris* or other members of the Family Cyprinidæ.

According to Herre (1928) the carp planted in Laguna de Bay showed a surprising growth, increasing rapidly in length and breadth and maturing sexually in ten months. Because of this development and the frequent catches of this fish by the people around the lake, he is of the opinion that it will never become extinct in its new home. If our surmise that it has been responsible for the introduction of *Diphyllobothrium latum* into this locality is correct, it would seem that a new endemic focus of this infestation has been established in the Philippines. We predict that more cases will appear among the inhabitants of the lake region, and that autopsies of dogs and cats of this area will yield more specimens of this tapeworm. This would mean a new parasitic disease of clinical and public-health importance in this country.

SUMMARY AND CONCLUSION

A diphyllobothrid tapeworm answering the description of *Diphyllobothrium latum* (Linnæus, 1758) Lühe, 1910, has been recovered from a native Filipino child, who died with clinical symptoms of pernicious anæmia. The authors believe that this cestode has been recently introduced into the Philippines from a foreign endemic focus, probably either China or Japan. They base their belief on the following grounds: (*a*) This infestation has never been encountered hitherto in native Filipinos, despite years of active helminthologic surveys and thousands of autopsies both in Manila and other parts of the country; (*b*) the infestation has been detected in a town located right on the shore of Laguna de Bay precisely where *Cyprinus carpio,* a species of fish belonging to the barbus group (which includes the secondary intermediate hosts of this diphyllobothrid in China) was introduced successfully from the latter country eight years ago; (*c*) extensive autopsies of cats and dogs, for many years, have failed to detect this infestation among these animals, which

would not have been the case had this diphyllobothrid long been endemic in the country. The authors predict that more cases of this infestation will appear among the inhabitants of this area, and that this tapeworm, if searched for, will also be found in cats and dogs of the same locality. This means a new parasitic disease of clinical and public-health interests in the Philippines.

ACKNOWLEDGMENT

We are indebted to Mr. Agustin Umali, of the Fish and Game Administration, Bureau of Science, for giving us information about the carp in the Philippine lakes.

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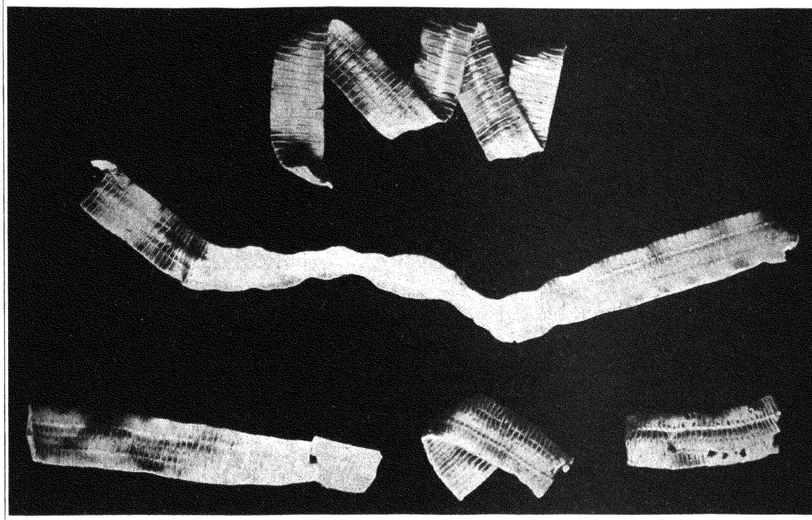
ILLUSTRATION

PLATE 1. DIPHYLLOBOTHRIUM LATUM (LINNÆUS, 1758) LÜHE, 1910

FIG. 1. Fragmented strobila of the worm; preserved in 5 per cent formalin.

2. An egg, × 638.

3. A mature segment; *cgp*, common genital pore; *ov*, ovary; *t*, testis; *va*, vagina; *vg*, vitelline glands; *utc*, uterine coils; *utp*, uterine pore.



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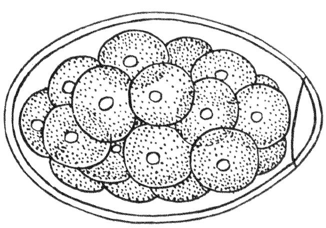

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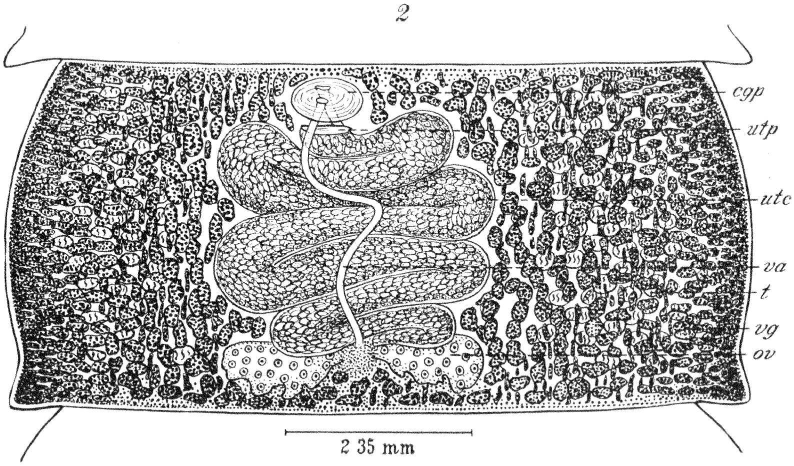

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PLATE 1.

TERATOLOGY OF PHILIPPINE ORCHIDS, II

By EDUARDO QUISUMBING

Curator, Philippine National Herbarium, Bureau of Science, Manila

ONE PLATE

This is a continuation of my studies on the teratology of Philippine orchids.[1] From time to time orchid enthusiasts of Manila have furnished me with materials for this paper. All flowers reported in this paper are preserved in liquid and deposited in the Philippine National Herbarium.

PAPHIOPEDILUM ARGUS (Reichb. f.) Stein. Plate 1, fig. 13.

This is a very common ground orchid in the Philippines. All the floral organs are normal and typical of the species except one of the petals with a pouchlike concave apex. The specimen was collected from a plant belonging to Mrs. K. B. Day, March, 1935.

DENDROBIUM ANOSMUM Lindl. Plate 1, fig. 17.

The figure was prepared under the direction of former Director Merrill of the Bureau of Science, at present director-in-chief of the New York Botanical Garden. The flower on the left is typical of the species. The double flower had only five sepals, the sixth one being diverted into a lip. There are three lips, the basal one being largest. The petals are normally four. The column is much enlarged with three anther caps. Collected by Mr. W. S. Lyon, Manila, March 26, 1919.

PHALAENOPSIS EQUESTRIS (Schauer) Reichb. f.

Cases of winged columns were reported in *Phalaenopsis aphrodite* and *P. schilleriana* but none from this species. The following have been observed:

Case 1.—The dorsal sepal and petals are normal. The two lateral sepals are absent. The front lobe of the lip approaches in size a typical form, with the exception of a small appendage at the margin and on the surface. One lateral lobe of the lip is present, and this slightly longer than the normal one. The

[1] Orch. Rev. 39 (1931) 131, *fig. 1;* Philip. Journ. Sci. 49 (1932) 137–139, *3 pls.*

specimen was collected from a plant owned by Mrs. Remedios C. Gonzalez, December 19, 1932; figs. 6 and 7.

Case 2.—This is one of the most interesting teratological cases in this species. The "Siamese Twins" has two normal flowers, joined back to back with one common pedicellate ovary. The "twins" were kindly supplied the author by Mrs. Helen Leas Cothran, March 27, 1935; figs. 10 to 12.

Case 3.—All the floral organs are complete and normal with the exception of the column which is capped with a prominent hood. The column is provided with a very thin, membranaceous, winged appendage, attached on both sides of the column. The specimen was collected from a plant owned by Mrs. K. B. Day, January 31, 1935; figs. 8 and 9.

Case 4.—All floral organs are typical of the species except the two petals which were decidedly abnormal. Except the width, the more intense coloration and the absence of the lateral lobes, these petals approximated to the labellum. At the base of each petal is a sharp, thin appendage which looks like a rudimentary callus. The flowers on the peduncles were much more handsome than the normal flowers. The leaves are typical of *P. equestris.* The specimen was kindly supplied the author by Mr. Emilio Ermitaño, August 7, 1933; fig. 16.

PHALAENOPSIS SANDERIANA Reichb. f.

This is one of the most unusual freaks ever met in the genus *Phalaenopsis.* The color and texture of the floral parts suggest very close resemblance to a typical *Phalaenopsis sanderiana,* but the habit of the plant and the color and texture of the leaves are typically of *Phalaenopsis lueddemanniana.* The leaves are oblanceolate, fleshy, green on both surfaces, about 21 cm long, 8.7 cm wide. The inflorescence is about 20 cm long with 9 to 11 flowers. The flower (fig. 18) when fully opened is 5.7 to 6 cm across. The dorsal sepal is oblong, about 3.5 cm long and 1.8 cm wide. The lateral sepals are slightly oblique lanceolate, about 3.3 cm long, 1.5 cm wide. The true lip is entirely absent, and in its place is a structure similar in shape and texture to the petals, about 3.4 cm long, 1.5 cm wide. The column (figs. 14 and 15) is short and stout with three appendages on top. The anther is absent. The plant was collected by District Engineer A. Aquino from the forests between Cebu and Toledo, Cebu Island, and the specimen under description was brought to Manila by Mr. Aquino April 2, 1935. Accord-

ing to Mr. Aquino, the plant has flowered twice during this year, and in both flowerings, all flowers were of this nature.

SPATHOGLOTTIS PLICATA Blume. Plate 1, fig. 5.

Costerus and Smith [2] reported a case in this species showing transformation of petals into labella. In my first paper (l. c.), I mentioned a case in which the dorsal sepal was intimately united with the right petal. In this particular case the dorsal sepal is confluent with the petal halfway from the base only.

GRAMMATOPHYLLUM SCRIPTUM (Linn.) Blume. Plate 1, fig. 2.

These abnormal flowers are usually found at the base of the peduncles, charaterized by the suppression of organs. The dorsal sepal and petals are both normal in size and color. The lateral sepals are confluent, the joined structures are slightly larger than the dorsal sepal. The labellum is completely absent and in its place are the confluent lateral sepals. The column is much smaller than the normal one, otherwise it is complete in its parts. The specimen was collected in Mrs. Applegate's gardens at Santa Mesa, Manila, June 15, 1934.

GRAMMATOPHYLLUM SPECIOSUM Blume.

The flower (fig. 1) has normal dorsal sepal and petals. The lateral sepals are confluent. The labellum is absent and in its place are the confluent lateral sepals. The column is a much reduced structure. The specimen was collected among the plants in the orchid house of Mrs. Remedios C. Gonzales, Manila, February, 1934.

Figures 3 and 4 were from a much reduced flower. The flower has only two floral segments and the column was very much reduced. From the collections of Mrs. Remedios C. Gonzales.

[2] Ann. Jard. Bot. Buitenzorg 28 (1914) 133.

ILLUSTRATION

PLATE 1

FIG. 1. *Grammatophyllum speciosum* Blume, front view of flower, × 0.33.
2. *Grammatophyllum scriptum* (Linn.) Blume, front view of flower, × 0.33.
3. *Grammatophyllum speciosum* Blume, front view of flower, × 0.33.
4. *Grammatophyllum speciosum* Blume, side view of flower, × 0.33.
5. *Spathoglottis plicata* Blume, front view of flower, × 0.66.
6. *Phalaenopsis equestris* (Schauer) Reichb. f., front view of flower, × 0.66.
7. *Phalaenopsis equestris* (Schauer) Reichb. f., labellum from above, × 1.33.
8. *Phalaenopsis equestris* (Schauer) Reichb. f., front view of colmun, × 1.33.
9. *Phalaenopsis equestris* (Schauer) Reichb. f., side view of column, × 1.33.

FIGS. 10 to 12. *Phalaenopsis equestris* (Schauer) Reichb. f., different views of "Siamese Twins," × 0.66.

FIG. 13. *Paphiopedilum argus* (Reichb. f.) Stein, front view of flower, × 0.33.
14. *Phalaenopsis sanderiana* Reichb. f., front view of column, × 1.33.
15. *Phalaenopsis sanderiana* Reichb. f., side view of column, × 1.33.
16. *Phalaenopsis equestris* (Schauer) Reichb. f., front view of flower, × 0.66.
17. *Dendrobium anosmum* Lindl., normal and double flowers, × 0.33.
18. *Phalaenopsis sanderiana* Reichb. f., front view of flower, × 0.33.

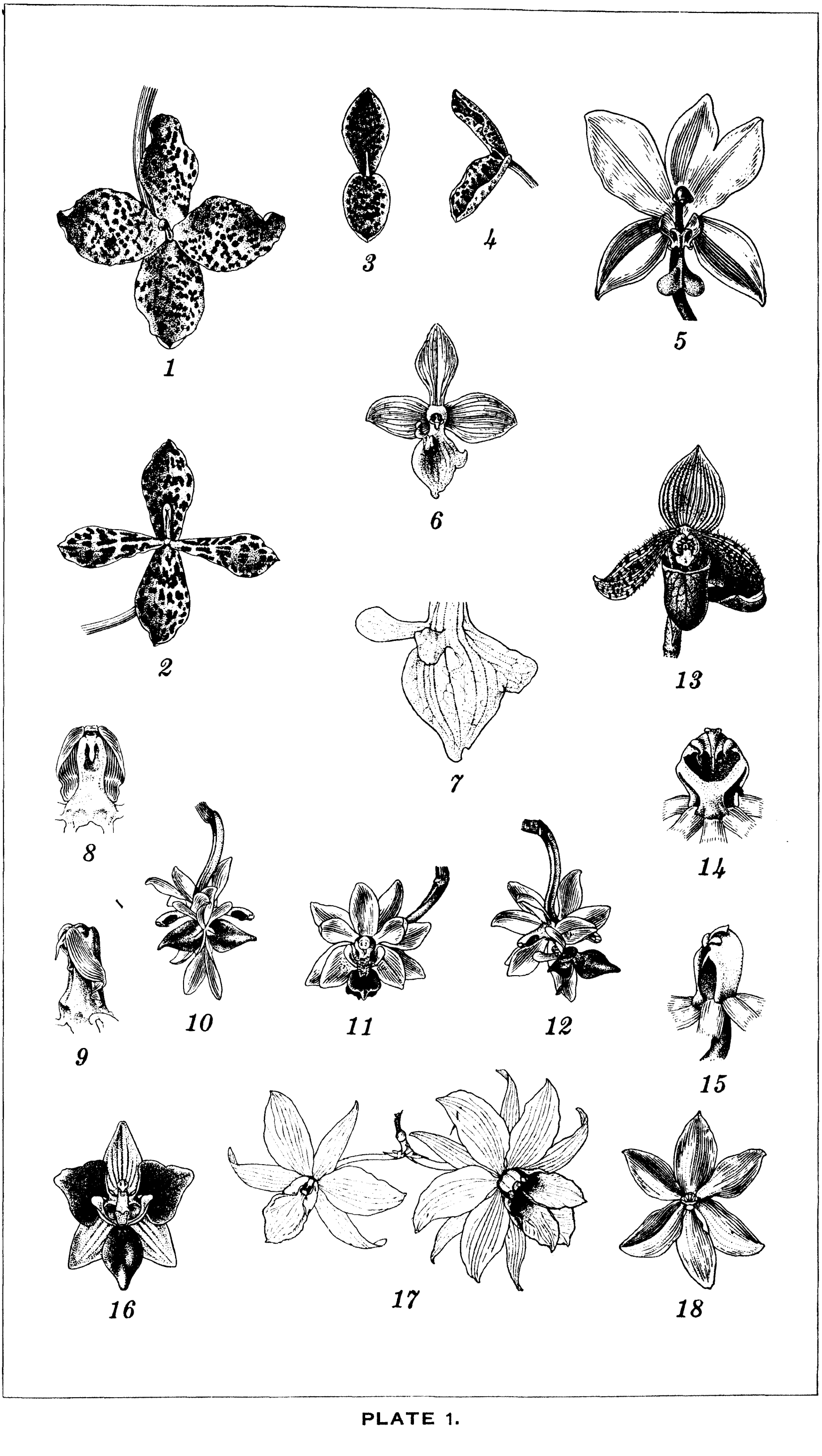

PLATE 1.

DIATOMS FROM POYANG LAKE, HUNAN, CHINA

By B. W. SKVORTZOW

Of Harbin, Manchoukuo

THREE PLATES

The diatoms described in the following paper were collected in October, 1929, by the Rev. Umberto Verdini in the Eastern Lake of the City of Poyang, Hunan, China, on lotus leaves. This collection was received through the kindness of Mr. A. Beltchenko, of Hankow. The collection from Poyang contained eighty-four species and varieties of diatoms, among which were found eleven new forms. They are as follows:

Synedra rumpens var. *sinica.*
Neidium hitchcockii var. *oblique-striatum.*
Navicula exigua var. *sinica.*
Navicula lambda Cleve var. *sinica.*
Navicula menisculus var. *sinica.*
Pinnularia interrupta var. *sinica.*
Pinnularia subsolaris var. *interrupta.*
Pinnularia subcapitata var. *sinica.*
Gomphonema acuminatum var. *sinica.*
Nitzschia bremensis var. *sinica.*
Nitzschia palea var. *gracilis.*

The diatoms of Poyang Lake have never been listed and so may be of interest. The species found in this collection are here enumerated.

CYCLOTELLA MENEGHINIANA Kutz. Plate 1, fig. 1.

Cyclotella meneghiniana F. HUSTEDT, Bacillar. (1930) 100, fig. 67.

Frustule, 0.01 mm in diameter. Costæ 8 in 0.01 mm. Central areas hyaline. A common fresh-water diatom.

CYCLOTELLA MENEGHINIANA Kutz. var. TENERA Kolbe. Plate 1, fig. 2.

Cyclotella meneghiniana Kutz. var. *tenera* KOLBE, Zur Okologie, Morph. u. System. d. Brackwasser Diatom. (1927) 33, pl. 1, figs. 17, 18.

Frustule, 0.015 mm in diameter. Costæ robust, 8 in 0.01 mm. Central areas with isolated puncta. Known from Europe.

CYCLOTELLA STELLIGERA Cleve and Grunow. Plate 1, fig. 3.

Cyclotella stelligera F. HUSTEDT, Bacillar. (1930) 100, fig. 65.

Frustule, 0.007 to 0.013 mm in diameter. Costæ 12 to 15 in 0.01 mm. Central areas with stellate ornamentation. A fresh-water species.

MELOSIRA GRANULATA (Ehr.) Ralfs. Plate 1, fig. 4.

Melosira granulata F. HUSTEDT, Bacillar. (1930) 87, fig. 44.

Frustule, 0.005 to 0.01 mm broad. Striæ punctate, 7 to 12 in 0.01 mm.

MELOSIRA GRANULATA (Ehr.) Ralfs forma **CURVATA** Grun. Plate 1, fig. 5.

Melosira granulata (Ehr.) Ralfs forma *curvata* F. HUSTEDT, Bacillar. (1930) 88.

Frustule curved, 0.0042 mm broad. Striæ punctate, 18 to 20 in 0.01 mm.

MELOSIRA GRANULATA (Ehr.) Ralfs var. **ANGUSTISSIMA** O. Mull. Plate 1, fig. 6.

Melosira granulata (Ehr.) Ralfs var. *angustissima* F. HUSTEDT, Bacillar. (1930) 88, fig. 45.

Frustule very narrow, 0.003 to 0.004 mm broad. Very common in fresh water.

MELOSIRA DISTANA (Ehr.) Kutz. Plate 1, fig. 7.

Melosira distana (Ehr.) F. HUSTEDT, Bacillar. (1930) 92, 93, fig. 53.

Frustule cylindrical, 0.005 mm broad. Striæ punctate, 15 in 0.01 mm. Common in fresh water.

FRAGILARIA CAPUCINA Desm. Plate 1, fig. 8.

Fragilaria capucina F. HUSTEDT, Bacillar. (1930) 138, fig. 26.

Valve linear-lanceolate with truncate rounded ends. Length, 0.024 mm; breadth, 0.0025; striæ 11 in 0.01 mm. A well-known fresh-water species.

SYNEDRA VAUCHERIAE Kutz. var. **TRUNCATA** (Greville) Grun. Plate 1, fig. 9.

Synedra vaucheriae Kutz. var. *truncata* (Greville) F. HUSTEDT, Bacillar. (1930) 161, fig. 193.

Valve linear-lanceolate with obtuse ends. Length, 0.017 mm; breadth, 0.004. A fresh-water species.

SYNEDRA ULNA (Nitzsch.) Ehr. Plate 1, fig. 10.

Synedra ulna (Nitzsch.) F. HUSTEDT, Bacillar. (1930) 151, 152, fig. 159*b*.

Valve linear-lanceolate, rostrate. Length, 0.03 mm; breadth, 0.006; striæ 9 in 0.01 mm. Common in fresh water.

SYNEDRA ULNA (Nitzsch.) Ehr. var. BICEPS Kutz. Plate 1, fig. 11.

Synedra ulna (Nitzsch.) Ehr. var. *biceps* F. HUSTEDT, Bacillar. (1930) 154, fig. 166*a*, *b*.

Valve with capitate ends. Length, 0.25 mm; breadth, 0.006; striæ 6 in 0.01 mm.

SYNEDRA PULCHELLA Kutz. var. LANCEOLATA O. Meara. Plate 1, fig. 12.

Synedra pulchella Kutz. var. *lanceolata* F. HUSTEDT, Bacillar. (1930) 160, fig. 187.

Valve very small, with truncate ends. Length, 0.02 mm; breadth, 0.0045; striæ 9 in 0.01 mm.

SYNEDRA RUMPENS Kutz. var. SCOTICA Grun. Plate 1, fig. 14.

Synedra rumpens Kutz. var. *scotica* F. HUSTEDT, Bacillar. (1930) 156, fig. 177.

Valve lanceolate with attenuate end. Length, 0.035 mm; breadth, 0.025; striæ 18 in 0.01 mm.

SYNEDRA RUMPENS Kutz. var. SINICA var. nov. Plate 1, fig. 13.

Valve lanceolate with rounded ends. Length, 0.095 mm; breadth, 0.005; striæ 11 to 12 in 0.01 mm. Differs from the type in its larger size.

EUNOTIA LUNARIS (Ehr.) Grun. Plate 1, fig. 15.

Eunotia lunaris F. HUSTEDT, Bacillar. (1930) 183, 184, fig. 249.

Valve linear, lunate, with rounded ends. Length, 0.096 mm; breadth, 0.0034; striæ 12 in 0.01 mm. A fresh-water species.

ACHNANTHES HUNGARICA Grun. Plate 1, figs. 16 to 19.

Achnanthes hungarica F. HUSTEDT, Bacillar. (1930) 201, fig. 283.

Valve linear-lanceolate, parallel in the middle part with cuneate and rounded ends. Length, 0.013 to 0.034 mm; breadth, 0.006 to 0.007; striæ 18 to 24 in 0.01 mm. A fresh-water species.

COCCONEIS PLACENTULA (Ehr.) var. EUGLYPTA (Ehr.) Cleve. Plate 1, fig. 20.

Cocconeis placentula (Ehr.) var. *euglypta* F. HUSTEDT, Bacillar. (1930) 190, fig. 261.

Valve elliptical. Length, 0.015 mm; breadth, 0.01. Common in fresh water.

NEIDIUM AFFINE (Ehr.) Cleve var. AMPHIRHYNCHUS (Ehr.) Cleve. Plate 1, fig. 21.

Neidium affine (Ehr.) Cleve var. *amphirhynchus* F. HUSTEDT, Bacillar. (1930) 243, fig. 377.

Valve linear, slightly gibbous in the middle with truncate, rounded ends. Length, 0.045 mm; breadth, 0.011; striæ 30 in 0.01 mm. A fresh-water species.

NEIDIUM HITCHCOCKII Ehr. var. OBLIQUE-STRIATUM var. nov. Plate 1, fig. 22.

Valve triundulate with rostrate ends. Length, 0.059 mm; breadth, 0.001; striæ oblique, 16 to 18 in 0.01 mm. Differs from the type by its oblique striæ.

NEIDIUM PRODUCTUM (W. Smith) Cleve. Plate 1, fig. 23.

Neidium productum F. HUSTEDT, Bacillar. (1930) 245, fig. 383.

Valve broad lanceolate with rostrate ends. Length, 0.064 mm; breadth, 0.018; striæ 18 to 20 in 0.01 mm. A fresh-water diatom.

CALONEIS BACILLUM (Grun.) Meresch. Plate 1, fig. 24.

Caloneis bacillum F. HUSTEDT, Bacillar. (1930) 236, fig. 360*a*.

Valve linear with parallel margins and rounded ends. Length, 0.025 mm; breadth, 0.006; striæ slightly radiate, 24 in 0.01 mm. Central areas a broad transverse fascia.

CALONEIS BACILLUM (Grun.) Meresch. var. TRUNCULATA Grun. forma. Plate 1, fig. 25.

Valve slightly gibbous on the middle. Length, 0.03 mm; breadth, 0.0052; striæ 21 in 0.01 mm, bilaterally interrupted. A fresh- and brackish-water species.

CALONEIS CLEVEI (Lagerst.) Cleve. Plate 1, fig. 26.

Caloneis clevei F. HUSTEDT, Bacillar. (1930) 236, fig. 359.

Valve lanceolate, slightly undulate with broad rounded ends. Length, 0.042 mm; breadth, 0.007; striæ slightly radiate, 18 in 0.01 mm. Axial areas narrow, dilated in the middle to a transverse fascia. A fresh-water species, known from Europe.

CALONEIS SILICULA (Ehr.) Cleve var. GIBBERULA (Kutz.) Grun. Plate 1, fig. 27.

Caloneis silicula (Ehr.) Cleve var. *gibberula* F. HUSTEDT, Bacillar. (1930) 238, fig. 365.

Valve slightly triundulate with rounded ends. Length, 0.056 mm; breadth, 0.01; striæ radiate, 18 in 0.01 mm. Axial areas somewhat dilated in the middle part. A fresh- and brackish-water species.

GYROSIGMA ACUMINATUM (Kutz.) Rabh. Plate 2, fig. 1.

Gyrosigma acuminatum F. HUSTEDT, Bacillar. (1930) 223, fig. 329.

Valve sigmoid with attenuate ends. Length, 0.091 mm; breadth, 0.013; striæ longitudinal and transversal, 18 in 0.01 mm. Common in fresh water.

STAURONEIS PHOENICENTERON Ehr.

Stauroneis phoenicenteron F. HUSTEDT, Bacillar. (1930) 255, fig. 404.

Valve lanceolate, attenuate. Length, 0.178 mm; breadth, 0.04.

STAURONEIS ANCEPS Ehr. forma GRACILIS (Ehr.) Cleve. Plate 2, fig. 2.

Stauroneis anceps Ehr. forma *gracilis* F. HUSTEDT, Bacillar. (1930) 256, fig. 406.

Valve robust with capitate ends. Length, 0.107 mm; breadth, 0.025. Common in fresh water.

NAVICULA HUNGARICA Grun. var. CAPITATA (Ehr.) Cleve. Plate 1, fig. 28.

Navicula hungarica Grun. var. *capitata* F. HUSTEDT, Bacillar. (1930) 298, fig. 508.

Valve lanceolate, gibbous in the middle, rostrate at the ends. Length, 0.021 mm; breadth, 0.0076; striæ robust, radiate, 7 in 0.01 mm. Common in fresh water.

NAVICULA EXIGUA (Greg.) O. Mull. var. SINICA var. nov. Plate 1, fig. 29.

Valve lanceolate with broad rounded margins and short rostrate ends. Axial areas narrow, somewhat dilated in the middle. Striæ radiate in the middle part, shortened, 17 to 18 in 0.01 mm. Length, 0.018 mm; breadth, 0.0068. This new variety differs from the type in its smaller size and its finer striæ.

NAVICULA PUPULA Kutz. Plate 1, figs. 30, 31.

Navicula pupula F. HUSTEDT, Bacillar. (1930) 281, fig. 467*a*.

Valve lanceolate with truncate ends. Striæ radiate, 24 in 0.01 mm. Axial areas dilated in the middle. Length, 0.018 to 0.024 mm; breadth, 0.007. A common fresh-water species.

NAVICULA PUPULA Kutz. var. CAPITATA Hust. Plate 1, fig. 32.

Navicula pupula Kutz. var. *capitata* F. HUSTEDT, Bacillar. (1930) 281, fig. 467*c*.

Valve linear-lanceolate with capitate ends. Median line narrow. Central areas a broad stauros, widened and truncate outwards. Striæ radiate, 24 in 0.01 mm. Length, 0.039 mm; breadth, 0.0085.

NAVICULA PUPULA Kutz. var. ROSTRATA Hust. Plate 1, fig. 33.

Navicula pupula Kutz. var. *rostrata* F. HUSTEDT, Bacillar. (1930) 282, fig. 467*e*.

Valve lanceolate with rounded ends. Length, 0.015 mm; breadth, 0.0068; striæ 25 in 0.01 mm.

NAVICULA LAMBDA Cleve var. SINICA var. nov. Plate 1, fig. 34.

Valve linear, not constricted, rectangular with broad ends. Striæ nearly parallel, 21 to 24 in 0.01 mm. Median line narrow. Length, 0.023 mm; breadth, 0.007. Differs from the type by its small size. *Navicula lambda* is known from Demerara River, Brazil.

NAVICULA AMERICANA Ehr. Plate 1, fig. 35.

Navicula americana F. HUSTEDT, Bacillar. (1930) 280, fig. 464.

Valve rectangular with broad ends. Axial areas narrow. Median line in a thick siliceous rib. Striæ subradiate, 18 in 0.01 mm. Length, 0.037 mm; breadth, 0.013. Not common.

NAVICULA CUSPIDATA Kutz. Plate 2, fig. 3.

Navicula cuspidata F. HUSTEDT, Bacillar. (1930) 268, fig. 433.

Valve lanceolate with attenuated ends. Transverse striæ 12 in 0.01 mm; longitudinal striæ 30 in 0.01 mm. Length, 0.102 mm; breadth, 0.024. Not common.

NAVICULA CRYPTOCEPHALA Kutz. Plate 1, fig. 36.

Navicula cryptocephala F. HUSTEDT, Bacillar. (1930) 295, fig. 496.

Valve lanceolate with attenuated ends. Striæ radiate, divergent in the middle, 15 in 0.01 mm. Axial areas narrow. Length, 0.032 mm; breadth, 0.007. A fresh- and brackish-water species.

NAVICULA CRYPTOCEPHALA Kutz. var. **EXILIS** (Kutz.) Grun. Plate 1, fig. 37.

Navicula cryptocephala Kutz. var. *exilis* F. HUSTEDT, Bacillar. (1930) 295.

Valve lanceolate with short ends. Striæ radiate, 20 in 0.01 mm. Length, 0.024 mm; breadth, 0.0068.

NAVICULA MENISCULUS Schumann var. **SINICA** var. nov. Plate 1, fig. 38.

Valve broad-lanceolate, gibbous in the middle. Striæ 10 in 0.01 mm; divergent and shortened in the middle. Axial areas narrow, central areas slightly tranversely dilated. Length, 0.037 mm; breadth, 0.009. This new variety differs from the type in its size. Also found at Yentsche, Chansi.

PINNULARIA PLATYCEPHALA (Ehr.) Cleve forma. Plate 2, fig. 14.

Valve broad-linear, with large capitate ends. Striæ divergent in the middle, convergent at the ends, 9 in 0.01 mm. Length, 0.072 mm; breadth, 0.015.

PINNULARIA PLATYCEPHALA Cleve var. **HATTORIANA** Meister. Plate 2, fig. 4.

Pinnularia platycephala Cleve var. *hattoriana* MEISTER, Beiträge z. Bacillar. Japans. 2 (1914) 228, pl. 8, figs. 6, 7.

Valve linear, triundulate, slightly attenuate, with rounded ends. Striæ 12 in 0.01 mm, divergent at the ends. Central areas a broad transverse fascia. Median line straight, terminal fissures bayonet-shaped. Length, 0.078 mm; breadth, 0.013. Known from Nippon only.

PINNULARIA SUBCAPITATA Greg. var. **PAUCISTRIATA** Grun. Plate 2, fig. 5.
Pinnularia subcapitata Greg. var. *paucistriata* V. HEURCK, Synopsis (1880–81) pl. 6, fig. 23.

Valve linear-lanceolate with parallel margins. Axial areas somewhat dilated in the middle to a transverse fascia. Striæ radiate, 12 to 15 in 0.01 mm. Length, 0.017 to 0.02 mm; breadth, 0.006.

PINNULARIA SUBCAPITATA Greg. var. **SINICA** var. nov. Plate 2, fig. 6.

Valve lanceolate with truncate ends. Striæ 15 in 0.01 mm. Length, 0.017 mm; breadth, 0.0036. Differs from the type only in its size.

PINNULARIA INTERRUPTA W. Smith var. **SINICA** var. nov. Plate 2, fig. 7.

Valve lanceolate, constricted, with rostrate ends. Striæ almost parallel or slightly radiate, 9 to 10 in 0.01 mm. Central areas a broad transverse fascia. Length, 0.025 mm; breadth, 0.005. Differs from the type in its elongate ends. By its dimensions this form resembles forma *hankensis* Skvortz.

PINNULARIA SUBSOLARIS (Grun.) Cleve. Plate 2, fig. 8.
Pinnularia subsolaris F. HUSTEDT, Bacillar. (1930) 322, fig. 388.

Valve linear-lanceolate, slightly attenuate and rounded ends. Striæ slightly radiate, 10 in 0.01 mm. Median line somewhat dilated in the middle. Length, 0.047 mm; breadth, 0.01. A fresh-water diatom.

PINNULARIA SUBSOLARIS (Grun.) Cleve var. **INTERRUPTA** var. nov. Plate 2, fig. 9.

Valve lanceolate with rounded ends. Central areas a broad transverse fascia. Length, 0.047 mm; breadth, 0.009; striæ 9 in 0.01 mm.

PINNULARIA VIRIDIS (Nitzsch.) Ehr. Plate 2, fig. 10.
Pinnularia viridis A. SCHMIDT, Atlas Diatom. (1876) pl. 42, fig. 23.

Valve lanceolate, gibbous in the middle, attenuate at the ends. Striæ divergent in the middle, slightly convergent at the ends, 9 in 0.01 mm. Length, 0.06 mm; breadth, 0.014. Common in fresh water.

PINNULARIA GIBBA Ehr. Plate 2, fig. 11.
Pinnularia gibba F. HUSTEDT, Bacillar. (1930) 327, fig. 600*b*.

Valve linear, gibbous in the middle and attenuate at the ends. Striæ radiate, 11 in 0.01 mm, divergent in the middle, convergent at the ends. Central areas a broad fascia. Length, 0.054 mm; breadth, 0.0068. A fresh-water species.

PINNULARIA GIBBA Ehr. forma **SUBUNDULATA** Mayer. Plate 2, fig. 12.

Pinnularia gibba Ehr. forma *subundulata* F. HUSTEDT, Bacillar. (1930) 327, fig. 601.

Valve linear with subundulate margins. Length, 0.070 mm; breadth, 0.01; striæ 8 to 9 in 0.01 mm.

PINNULARIA BRAUNII (Grun.) Cleve var. **AMPHICEPHALA** (A. Mayer) Hust. Plate 2, fig. 13.

Pinnularia braunii (Grun.) Cleve var. *amphicephala* F. HUSTEDT, Bacillar. (1930) 319, fig. 578.

Valve linear with capitate ends. Median line a broad transverse fascia. Length, 0.035 mm; breadth, 0.0068; striæ radiate, 12 in 0.01 mm. An alpine species.

PINNULARIA DACTYLUS Ehr.

Valve linear-elliptic. Length, 0.14 mm; breadth, 0.013; striæ 6 in 0.01 mm.

AMPHORA VENETA (Kutz.). Plate 2, fig. 15.

Amphora veneta F. HUSTEDT, Bacillar. (1930) 345, fig. 631.

Valve lanceolate with gibbous dorsal margin. Length, 0.02 mm; breadth, 0.013; striæ 18 to 20 (middle) or 24 (ends) in 0.01 mm. A fresh- and brackish-water diatom.

AMPHORA OVALIS Kutz. Plate 2, fig. 16.

Amphora ovalis F. HUSTEDT, Bacillar. (1930) 342, fig. 628.

Valve gibbous. Length, 0.024 mm; breadth, 0.014; striæ without fascia, 15 in 0.01 mm. Common in fresh water.

AMPHORA OVALIS Kutz. var. **LIBYCA** (Ehr.) Cleve. Plate 2, fig. 17.

Amphora ovalis Kutz. var. *libyca* A. SCHMIDT, Atlas Diatom. (1875) pl. 26, fig. 105.

Valve asymmetrical with gibbous dorsal margins. Striæ radiate, 15 in 0.01 mm. In the middle opposite the stigma a broad fascia. Length, 0.024 mm; breadth, 0.015. A fresh-water species.

AMPHORA NORMANI Rabh. Plate 2, fig. 18.

Amphora normani F. HUSTEDT, Bacillar. (1930) 343, 344, fig. 630.

Valve lanceolate with oblique ends. Length, 0.015 mm; breadth, 0.0034. Common in mosses.

AMPHORA COFFEAEFORMIS Agardh var. Plate 2, fig. 19.

Valve lunate with attenuate ends. Length, 0.018 mm; breadth, 0.0034; striæ radiate, 15 in 0.01 mm. A brackish-water species.

CYMBELLA TUMIDA (Breb.) V. Heurck. Plate 2, figs. 20, 21.

Cymbella tumida F. HUSTEDT, Bacillar. (1930) 366, fig. 677.

Valve cymbiform with rostrate ends. Striæ divergent in the middle, convergent at the ends, 9 (dorsal) or 10 (ventral) in 0.01 mm. Length, 0.045 to 0.06 mm; breadth, 0.015 to 0.018. A fresh-water species.

CYMBELLA TUMIDA (Breb.) V. Heurck var. **BOREALIS** Grun. Plate 3, fig. 1.

Valve with elongate ends. Length, 0.092 mm; breadth, 0.022; striæ 7 to 8 in 0.01 mm.

CYMBELLA TURGIDA (Greg.) Cleve. Plate 3, fig. 2.

Cymbella turgida F. HUSTEDT, Bacillar. (1930) 358, fig. 660.

Valve cymbiform with attenuate ends. Length, 0.049 mm; breadth, 0.012; striæ 7 in 0.01 mm. A fresh-water species.

CYMBELLA VENTRICOSA Kutz. Plate 3, fig. 3.

Cymbella ventricosa F. HUSTEDT, Bacillar. (1930) 359, fig. 661.

Valve cymbiform. Length, 0.023 mm; breadth, 0.005; striæ 14 (dorsal) or 12 (ventral) in 0.01 mm.

GOMPHONEMA INTRICATUM Kutz. Plate 3, fig. 4.

Gomphonema intricatum F. HUSTEDT, Bacillar. (1930) 375, fig. 697.

Valve lanceolate, narrowed towards the ends. Length, 0.03 mm; breadth; 0.005; striæ 12 in 0.01 mm.

GOMPHONEMA PARVULUM (Kutz.) Grun. Plate 3, figs. 5, 6.

Gomphonema parvulum F. HUSTEDT, Bacillar. (1930) 372, fig. 713.

Valve with gibbous ends attenuated towards the rounded ends. Length, 0.017 mm; breadth, 0.005; striæ 15 in 0.01 mm.

GOMPHONEMA PARVULUM (Kutz.) Grun. var. **LAGENULA** (Kutz. Grun.) Hust. Plate 3, fig. 7.

Gomphonema parvulum (Kutz.) Grun. var. *lagenula* V. HEURCK, Synopsis (1880–81) pl. 25, fig. 7.

Valve gibbous in the middle with rostrate ends. Length, 0.025 mm; breadth, 0.007; striæ almost parallel, 15 in 0.01 mm.

GOMPHONEMA PARVULUM (Kutz.) Grun. var. **SUBELLIPTICA** Cleve. Plate 3, fig. 8.

Gomphonema parvulum (Kutz.) Grun. var. *subelliptica* F. HUSTEDT, Bacillar. (1930) 373, fig. 713*b*.

Valve minute with acute ends. Length, 0.012 mm; breadth, 0.0032; striæ 18 in 0.01 mm.

GOMPHONEMA ACUMINATUM Ehr. var. TURRIS (Ehr.) Cleve. Plate 3, fig. 9.

Gomphonema acuminatum Ehr. var. *turris* A. SCHMIDT, Atlas Diatom. (1902) pl. 239, figs. 33, 34.

Valve constricted, attenuate at the apex and elongate at the base. Length, 0.035 mm; breadth, 0.0068; striæ 12 to 15 in 0.01 mm.

GOMPHONEMA ACUMINATUM Ehr. var. SINICA var. nov. Plate 3, figs. 10, 11.

Valve clavate, broad, gibbous in the middle, slightly attenuate towards the apex and elongate towards the base. Striæ 9 to 10 in 0.01 mm, in the middle almost parallel, convergent at the apex. The median stria opposite the stigma shortened. Length, 0.039 to 0.051 mm; breadth, 0.012 to 0.013. This variety differs from var. *turris* in its broad margins.

GOMPHONEMA LANCEOLATUM Ehr. Plate 3, fig. 15.

Gomphonema lanceolatum A. SCHMIDT, Atlas Diatom. (1902) pl. 236, fig. 34.

Valve linear-lanceolate with attenuate ends. Length, 0.06 mm; breadth, 0.01; striæ almost parallel, 12 to 13 in 0.01 mm.

GOMPHONEMA CONSTRICTUM Ehr. var. CAPITATA (Ehr.) Cleve. Plate 3, figs. 12, 13.

Gomphonema constrictum Ehr. var. *capitata* F. HUSTEDT, Bacillar. (1930) 377, fig. 715.

Valve clavate with broad rounded apex. Length, 0.022 to 0.03 mm; breadth, 0.01 to 0.012.

GOMPHONEMA AUGUR Ehr. Plate 3, fig. 14.

Gomphonema augur F. HUSTEDT, Bacillar. (1930) 372, fig. 688.

Valve clavate with gibbous and capitate apex part. Length, 0.028 mm; breadth, 0.0085; striæ 12 in 0.01 mm.

EPITHEMIA ZEBRA (Ehr.) Kutz. var. SAXONICA (Kutz.) Grun. Plate 3, fig. 16.

Epithemia zebra (Ehr.) Kutz. var. *saxonica* F. HUSTEDT, Bacillar. (1930) 385, fig. 730.

Valve lunate with gibbous and dorsal sides. Length, 0.022 mm; breadth, 0.0085; striæ 12 in 0.01 mm. A fresh-water diatom.

EPITHEMIA TURGIDA (Ehr.) Kutz. var. GRANULATA (Ehr.) Grun. Plate 3, fig. 17.

Epithemia turgida (Ehr.) Kutz. var. *granulata* F. HUSTEDT, Bacillar. (1930) 387, fig. 734.

Valve linear-lanceolate with capitate ends. Length, 0.064 mm; breadth, 0.01. A fresh- and brackish-water diatom.

RHOPALODIA GIBBA (Ehr.) O. Mull. var. VENTRICOSA (Ehr.) Grun. Plate 3, fig. 18

Rhopalodia gibba (Ehr.) O. Mull. var. *ventricosa* F. HUSTEDT, Bacillar. (1930) 390, 391, fig. 741.

Valve broad-lanceolate. Length, 0.042 mm; breadth, 0.02.

NITZSCHIA AMPHIBIA Grun. Plate 3, figs. 12 to 22.

Nitzschia amphibia F. HUSTEDT, Bacillar. (1930) 414, fig. 793.

Valve lanceolate, narrowed towards the ends. Costæ 7 to 8, striæ 15 to 16, in 0.01 mm. Length, 0.012 to 0.04 mm; breadth, 0.034.

NITZSCHIA BREMENSIS Hust. var. SINICA var. nov. Plate 3, fig. 23.

Valve linear-lanceolate, slightly constricted in the middle, with acuminate and rounded ends. Costæ large, 8, striæ 24, in 0.01 mm. Length, 0.052 mm; breadth, 0.0885. Differs from the type in its broader valve. *Nitzschia bremensis* is known from fresh and brackish water.

NITZSCHIA FRUSTULUM (Kutz.) Grun. var. PERPUSILLA (Rabh.) Grun. Plate 3, fig. 24.

Nitzschia frustulum (Kutz.) Grun. var. *perpusilla* V. HEURCK, Synopsis (1880–81) pl. 99, fig. 6.

Valve lanceolate, attenuate at the ends. Costæ 15, striæ 20, in 0.01 mm. Length, 0.01 mm; breadth, 0.0025. A brackish-water diatom.

NITZSCHIA FASCICULATA Grun. Plate 3, fig. 25.

Nitzschia fasciculata V. HEURCK, Synopsis (1880–81) pl. 66, figs. 11 to 13.

Valve slightly sigmoid, narrow towards the ends. Length, 0.04 mm; breadth, 0.005; costæ 8, striæ 35, in 0.01 mm. A brackish-water diatom.

NITZSCHIA PALEACEA Grun. Plate 3, fig. 26.

Nitzschia paleacea F. HUSTEDT, Bacillar. (1930) 416, fig. 807.

Valve linear, attenuate towards the ends. Costæ 13 in 0.01 mm; length, 0.054 mm; breadth, 0.0025. Striæ very fine, indistinct. A fresh-water diatom.

NITZSCHIA PALEA (Kutz.) W. Smith. Plate 3, fig. 27.

Nitzschia palea F. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear-lanceolate with truncate and rounded ends. Length, 0.017 mm; breadth, 0.008; costæ 15, striæ 35, in 0.01 mm.

NITZSCHIA PALEA (Kutz.) W. Smith var. **GRACILIS** var. nov. Plate 3, fig. 28.

Valve linear, in the middle part parallel, attenuate towards the ends. Length, 0.028 mm; breadth, 0.002; costæ 15, striæ 35, in 0.01 mm. This form is connected with var. *tenuirostris.*

NITZSCHIA CAPITELLATA Hust. Plate 3, fig. 29.

Nitzschia capitellata F. HUSTEDT, Bacillar. (1930) 414, fig. 792.

Valve linear-lanceolate, attenuate towards the ends. Ends capitate. Length, 0.0; breadth, 0.0034; costæ 11, striæ 35, in 0.01 mm. A fresh- and brackish-water diatom.

NITZSCHIA ACICULARIS W. Smith. Plate 3, fig. 30.

Nitzschia acicularis F. HUSTEDT, Bacillar. (1930) 423, fig. 821.

Valve filiform, gibbous in the middle, acuminate at the ends. Length, 0.068 mm; breadth, 0.003; costæ 15 in 0.01 mm.

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. var. **XEROPHILA** Grun. Plate 3, figs. 32 to 35.

Hantzschia amphioxys (Ehr.) Grun. var. *xerophila* GRUNOW, Diatom. Franz Joseph Land (1884) 47.

Valve linear-lanceolate with rostrate ends. Length, 0.022 to 0.03 mm; breadth, 0.0052 to 0.0068; costæ 6 to 12 in 0.01 mm.

SURIRELLA ANGUSTATA Kutz. Plate 3, fig. 31.

Surirella angustata A. MAYER, Bacillar. d. Regensburg. Gewässer. (1912) 331, pl. 21, fig. 8.

Valve lanceolate, attenuate towards the ends. Length, 0.018 mm; breadth, 0.0058; costæ 6 in 0.01 mm. Common in fresh water.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Cyclotella meneghiniana* Kutz.
2. *Cyclotella meneghiniana* Kutz. var. *tenera* Kolbe.
3. *Cyclotella stelligera* Cleve and Grunow.
4. *Melosira granulata* (Ehr.) Ralfs status x.
5. *Melosira granulata* (Ehr.) Ralfs forma *curvata* Grun.
6. *Melosira granulata* (Ehr.) Ralfs var. *angustissima* O. Mull.
7. *Melosira distans* (Ehr.) Kutz.
8. *Fragilaria capucina* Desm.
9. *Synedra vaucheriae* Kutz. var. *truncata* (Grev.) Grun.
10. *Synedra ulna* (Nitzsch.) Ehr.
11. *Synedra ulna* (Nitzsch.) Ehr. var. *biceps* (Kutz.).
12. *Synedra pulchella* Kutz. var. *lanceolata* O. Meara.
13. *Synedra rumpens* Kutz. var. *sinica* var. nov.
14. *Synedra rumpens* Kutz. var. *scotica* Grun.
15. *Eunotia lunaris* (Ehr.) Grun.

FIGS. 16 to 19. *Achnanthes hungarica* Grun.

FIG. 20. *Cocconeis placentula* (Ehr.) var. *euglypta* (Ehr.) Cleve.
21. *Neidium affine* (Ehr.) Cleve var. *amphirhynchus* (Ehr.) Cleve.
22. *Neidium hitchcockii* Ehr. var. *obliquestriatum* var. nov.
23. *Neidium productum* (W. Smith) Cleve.
24. *Caloneis bacillum* (Grun.) Meresch.
25. *Caloneis bacillum* (Grun.) Meresch. var. *trunculata* Grun. forma.
26. *Caloneis clevei* (Lagerst.) Cleve.
27. *Caloneis silicula* (Ehr.) Cleve var. *gibberula* (Kutz.) Grun.
28. *Navicula hungarica* Grun. var. *capitata* (Ehr.) Cleve.
29. *Navicula exigua* (Greg.) O. Mull. var. *sinica* var. nov.

FIGS. 30 and 31. *Navicula pupula* Kutz.

FIG. 32. *Navicula pupula* Kutz. var. *capitata* Hust.
33. *Navicula pupula* Kutz. var. *rostrata* Hust.
34. *Navicula lambda* Cleve var. *sinica* var. nov.
35. *Navicula americana* Ehr.
36. *Navicula cryptocephala* Kutz.
37. *Navicula cryptocephala* Kutz. var. *exilis* (Kutz.) Grun.
38. *Navicula menisculus* Schumann var. *sinica* var. nov.

PLATE 2

FIG. 1. *Gyrosigma acuminatum* (Kutz.) Rabh.
2. *Stauroneis anceps* Ehr. forma *gracilis* (Ehr.) Cleve.
3. *Navicula cuspidata* Kutz.
4. *Pinnularia platycephala* Cleve var. *hattoriana* Meister.
5. *Pinnularia subcapitata* Greg. var. *paucistriata* Grun.

FIG. 6. *Pinnularia subcapitata* Greg. var. *asiatica* var. nov.
7. *Pinnularia interrupta* W. Smith var. *sinica* var. nov.
8. *Pinnularia subsolaris* (Grun.) Cleve.
9. *Pinnularia subsolaris* (Grun.) Cleve var. *interrupta* var. nov.
10. *Pinnularia viridis* (Nitzsch.) Ehr.
11. *Pinnularia gibba* Ehr.
12. *Pinnularia gibba* Ehr. forma *subundulata* Mayer.
13. *Pinnularia braunii* (Grun.) Cleve var. *amphicephala* (A. Mayer) Hustedt.
14. *Pinnularia platycephala* (Ehr.) Cleve forma.
15. *Amphora veneta* (Kutz.).
16. *Amphora ovalis* Kutz.
17. *Amphora ovalis* Kutz. var. *libyca* (Ehr.) Cleve.
18. *Amphora normani* Rabh.
19. *Amphora coffeaeformis* Agardh var.
FIGS. 20 and 21. *Cymbella tumida* (Breb.) Van Heurck.

PLATE 3

FIG. 1. *Cymbella tumida* (Breb.) Van Heurck var. *borealis* Grun.
2. *Cymbella turgida* (Greg.) Cleve.
3. *Cymbella ventricosa* Kutz.
4. *Gomphonema intricatum* Kutz.
FIGS. 5 and 6. *Gomphonema parvulum* (Kutz.) Grun.
FIG. 7. *Gomphonema parvulum* (Kutz.) Grun. var. *lagenula* (Kutz. Grun.) Hust.
8. *Gomphonema parvulum* (Kutz.) Grun. var. *subelliptica* Cleve.
9. *Gomphonema acuminatum* Ehr. var. *turris* (Ehr.) Cleve.
FIGS. 10 and 11. *Gomphonema acuminatum* Ehr. var. *sinica* var. nov.
12 and 13. *Gomphonema constrictum* Ehr. var. *capitata* (Ehr.) Cleve.
FIG. 14. *Gomphonema augur* Ehr.
15. *Gomphonema lanceolatum* Ehr.
16. *Epithemia zebra* (Ehr.) Kutz. var. *saxonica* (Kutz.) Grun.
17. *Epithemia turgida* (Ehr.) Kutz. var. *granulata* (Ehr.) Grun.
18. *Rhopalodia gibba* (Ehr.) O. Mull. var. *ventricosa* (Ehr.) Grun.
FIGS. 19 to 22. *Nitzschia amphibia* Grun.
FIG. 23. *Nitzschia bremensis* Hust. var. *sinica* var. nov.
24. *Nitzschia frustulum* (Kutz.) Grun. var. *perpusilla* (Rabh.) Grun.
25. *Nitzschia fasciculata* Grun.
26. *Nitzschia paleacea* Grun.
27. *Nitzschia palea* (Kutz.) W. Smith.
28. *Nitzschia palea* (Kutz.) W. Smith var. *gracilis* var. nov.
29. *Nitzschia capitellata* Hust.
30. *Nitzschia acicularis* W. Smith.
31. *Surirella angustata* Kutz.
FIGS. 32 to 35. *Hantzschia amphioxys* (Ehr.) Grun. var. *xerophila* Grun.

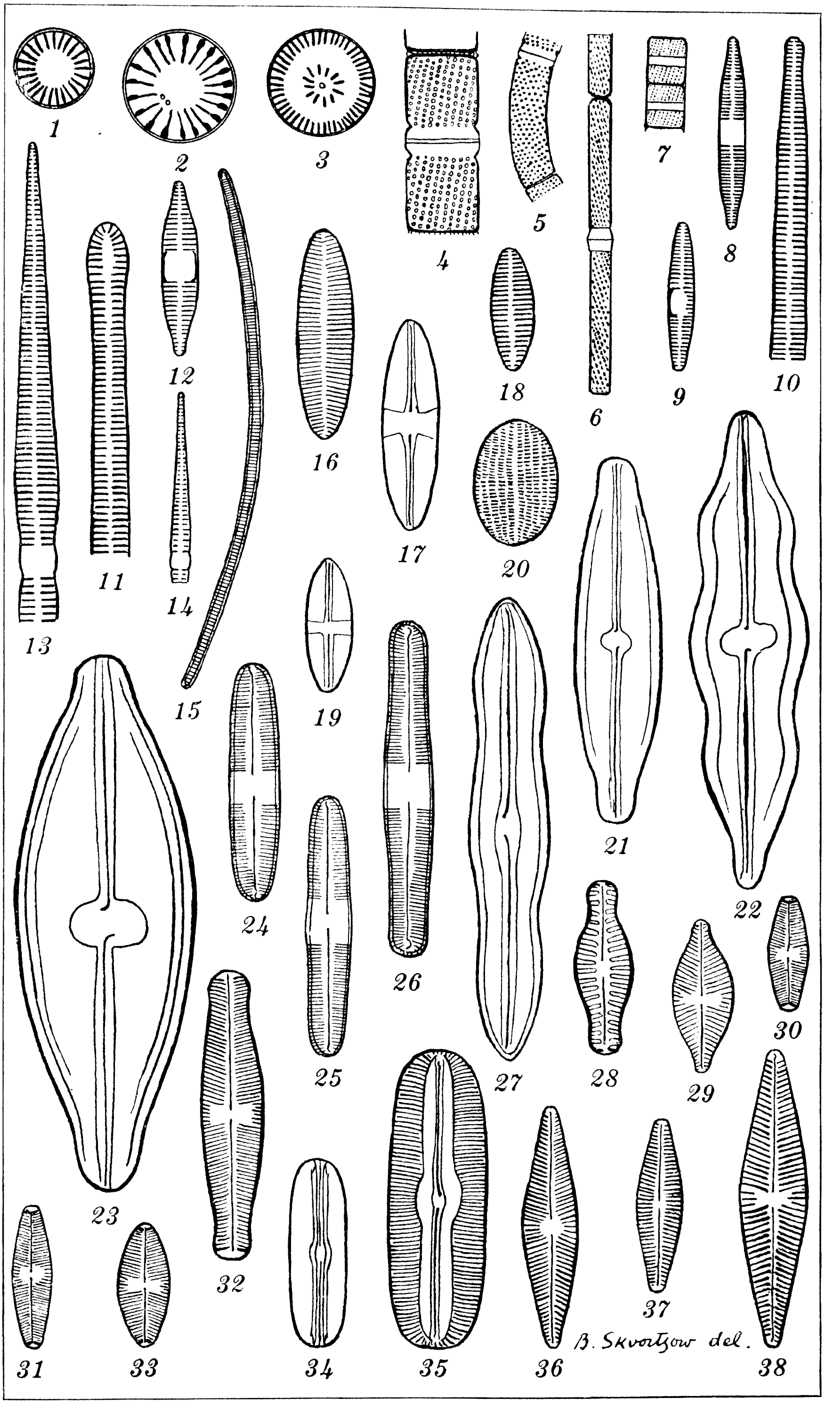
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PLATE 1.

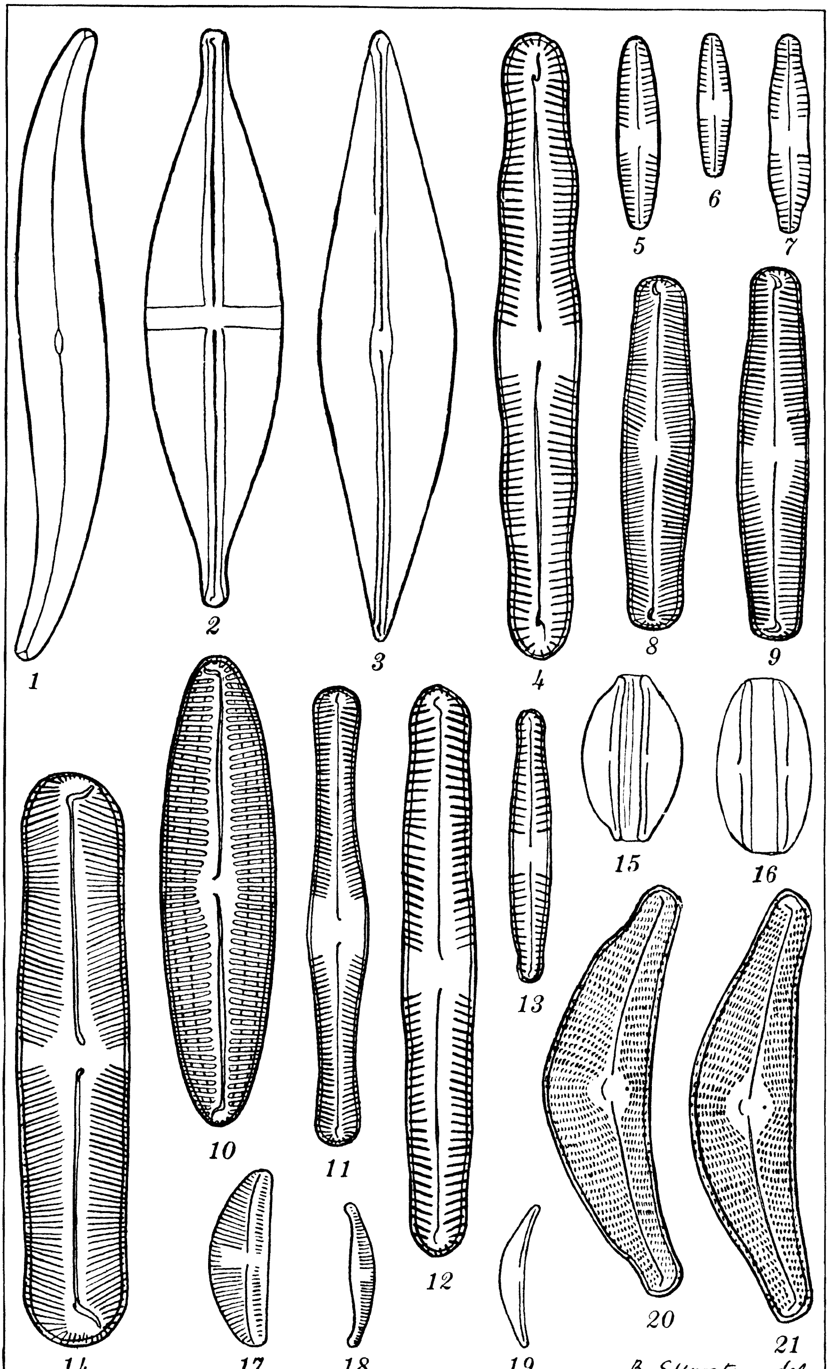

PLATE 2.

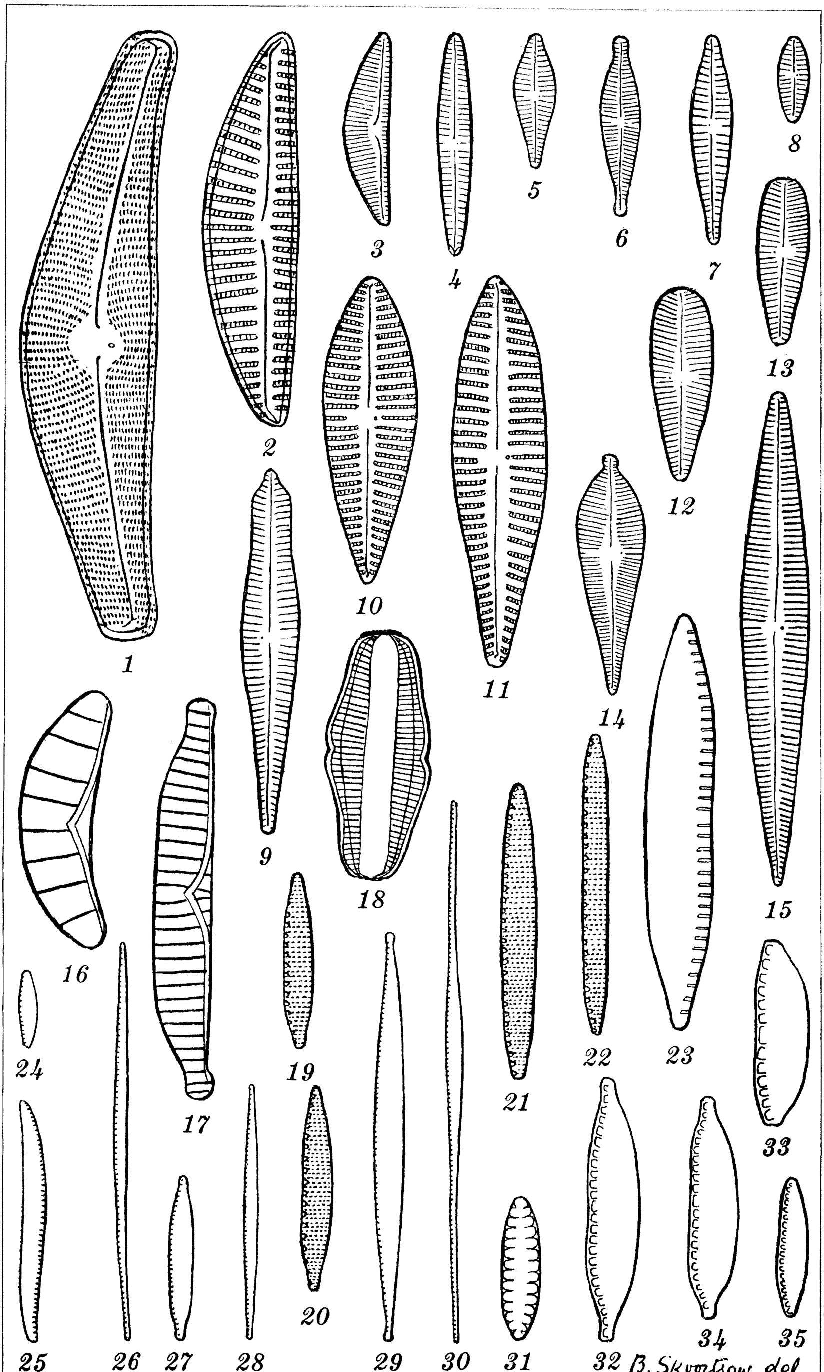
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PLATE 3.

SCOLYTIDÆ AND PLATYPODIDÆ:[1] NEW SPECIES FROM THE PHILIPPINE ISLANDS AND FORMOSA

By KARL E. SCHEDL

Of the Institut für angewandte Zoologie, Munich, Germany

XYLECHINUS FORMOSANUS sp. nov.

Reddish brown, opaque, 2.2 mm long, 2.17 times as long as wide. Front convex, darker than the general color, minutely reticulate and finely punctured.

Pronotum much wider than long (32 : 22), posterolateral angles rectangular, sides parallel on the basal fourth, then strongly convergent, apical margin broadly rounded; surface very feebly convex, uniformly, moderately, finely punctured and covered with scalelike hairs.

Elytra a little wider than (25 : 32) and 2.3 times as long as the pronotum, sides parallel, angulately rounded behind; base carinate, cylindrical on the basal three-fourths, uniformly convex behind, disc striate-punctate, strial punctures moderately large and densely place, interspaces moderately wide, convex and uniformly uniseriately punctured, from the punctures arise small inclined yellowish scales, the interspaces somewhat narrower on the declivity.

Type in my collection.

FORMOSA.

CROSSOTARSUS INUTILUS sp. nov.

Male.—Reddish brown, 3.5 mm long, four times as long as wide. Allied to *C. obtectus* m.

Front flat, opaque, densely roughly punctured, with scattered short erect hairs, rounded towards the vertex.

Pronotum much longer than wide (11 : 8), femoral grooves shallow, median sulcus long, surrounded by a narrow elongate patch of fine punctures, remaining surface shining, polished, subimpunctate.

Elytra wider than (9 : 8) and twice as long as the pronotum, sides parallel, with declivital armature similar to that of *C.*

[1] Thirty-second contribution.

obtectus m., but the lateral processes more strongly bent downwards and not so pointed; the declivital convexity more strongly developed, the puncturation of the disc much finer and the entire elytra strictly parallel-sided.

Female.—The female is of similar size and proportions. The front exactly as in the male, the pronotum with the patch of punctures much larger and long oval, the elytra obliquely narrowed behind, transverse at the apex, the elytral disc with the puncturation finer, the base of the third interstice elevated and transversely rugose, the declivity opaque, densely granulate, finely pubescent, convex above, perpendicular below.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Baguio, 1,600 meters altitude (*W. Schultze*).

CROSSOTARSUS SALTATOR sp. nov.

Male.—Yellowish brown, 3.2 mm long, 3.2 times as long as wide. Allied to *C. decorus* m., from Sumatra, but without carinate interstices on the declivity.

Front flat, rounded towards the vertex, coarsely punctured, sparsely hairy.

Pronotum longer than wide (9 : 8), femoral grooves shallow, median sulcus inconspicuous, surface shining and very sparsely finely punctured.

Elytra wider than (9.5 : 8) and twice as long as the pronotum, sides subparallel, feebly arcuate, somewhat convergent towards the apex, apical margin transverse, the lateral processes following the convexity of the declivity, bent downwards, representing the continuation of the fifth and sixth interstices, pointed at the extreme apex; base not carinate, disc hardly noticeably lineate-punctate, evenly convex from behind the middle to the apical margin, all interstices similar and feebly carinate and with a row of fine setose granules.

Female.—Female of the same size and proportions as the male, the front more finely punctured, the median sulcus of the pronotum more strongly developed, elytral disc with the puncturation more distinct, the carinate interstices of the declivity more weakly developed, the lateral processes short and blunt.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Nueva Vizcaya Province, Bayombong (*W. Schultze*).

CROSSOTARSUS TAYABASI sp. nov.

Male.—Reddish brown, 5 mm long, 2.7 times as long as wide. Allied to *C. subdepressus* m. but much stouter. I have separated this species out of a long series of *C. subdepressus* with which it seems to be associated on the food plant.

Front opaque, feebly transversely depressed above the epistomal margin, somewhat elevated and with a small puncture at the center, a few coarse punctures along the epistomal margin, densely but shallowly punctured and sparsely hairy above. Vertex separated from the front by an obtuse angle, antennal scape wider than long.

Pronotum quadrate, shining, femoral grooves distinct, median sulcus fine and long, surface with scattered fine punctures.

Elytra wider and 1.7 times as long as the pronotum, sides subparallel, cylindrical on the basal two-thirds, convex and with blunt downward-directed lateral processes behind; base feebly carinate, disc finely but distinctly lineate-punctate, the first row impressed, interspaces wide, polished, and with scattered fine punctures; declivity opaque, convex and granulate above, with a large lunate perpendicular impression below, the lateral processes broad triangular, the inner sides parallel.

Type in my collection.

LUZON, Tayabas Province, Quezon Park (*F. C. Hadden*).

CROSSOTARSUS SCHULTZEI sp. nov.

Male.—Blackish brown, 4 mm long, 4.6 times as long as wide. The declivital armature somewhat as in *Platypus aduncus* Chap., but belonging in the *Crossotarsi subdepressi.*

Front feebly broadly depressed, roughly densely punctured, with scattered erect yellow hairs.

Pronotum much longer than wide (13 : 9), femoral grooves long and deep, median sulcus very long and fine, surrounded by a very elongate patch of fine punctures, surface shining, hardly noticeably punctured.

Elytra hardly wider than pronotum and 1.95 times as long, base carinate, sides parallel, cylindrical, apex feebly convex, at the suture on the convexity emarginate, sutural corners at the apex produced, lateral processes very slender, the inner sides convergent, their apices somewhat blunt and with a small tooth external to the apical spur, a lunate depression from the processes to the suture; elytral disc with rows of hardly noticeable punctures except the first row, which is deeply impressed, inter-

spaces flat, polished, impunctate, granulate, and with yellowish pubescence on the upper declivital convexity.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Mount Santo Tomas (*W. Schultze*).

CROSSOTARSUS INIMICUS sp. nov.

Male.—Reddish brown; 2.8 mm long, five times as long as wide. A very slender species of the *Crossotarsi subdepressi.*

Front flat, sparsely coarsely punctured, rounded towards the vertex.

Pronotum 1.4 times as long as wide, widest at the posterior angles of the very deep and long femoral grooves, from there strongly narrowed towards the base, median sulcus very long but extremely fine, surface finely reticulate, with scattered fine punctures.

Elytra as wide and twice as long as the pronotum, sides parallel, cylindrical, nearly horizontal on the disc, the sides at the apex produced to form short lateral processes, when viewed from above the apex broadly emarginate, the declivity reduced to a small narrow lunate perpendicular space, disc shining, very finely lineate-punctate, interstices flat, subimpunctate, base of the third without any remarkable puncturation.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Mount Santo Tomas, on *Ficus* sp. (*W. Schultze*).

CROSSOTARSUS PERNANULUS sp. nov.

Yellowish brown, 2 mm long, 4.5 times as long as wide. This species is very closely allied to *C. inimicus* m., but is decidedly smaller, has the front separated from the vertex by an acute angle, the pronotum is subshining, 1.4 times as long as wide, the elytra as wide and 1.6 times as long as the pronotum, the lateral processes short and blunt, and with a small apical tubercle, the sides are serrate and feebly rounded, constricted, on a very short space before the lateral processes, the latter hardly produced beyond the transverse apical margin. The sex is rather uncertain.

Types in the possession of Mr. F. C. Hadden and in my collection.

LUZON, Laguna Province, Mount Maquiling, 400 feet altitude (*F. C. Hadden*).

CROSSOTARSUS FRACTUS Samps.

I have had the opportunity to compare my male specimens from the Philippines with the type, which is in the possession of Doctor Beeson at Dehra Dun. The variations within the species are rather remarkable, especially in regard to the declivital armature. Some specimens have the emargination at the suture distinctly wider than long, whereas in others it is strictly semicircular. The apical processes are from subparallel (the inner sides) to distinctly convergent, and there are also remarkable variations in size. All variations are not constant enough to justify the separation of subspecies or variations. The female, which has not been known, is described below.

Female.—Dark reddish brown, 4.7 mm long, three times as long as wide. Similar to the female of *C. squamulatus* Chap., but smaller and stouter.

Front flattened, with a depressed puncture medially, surface subshining, moderately finely punctured.

Pronotum quadrate, minutely reticulate, subshining, rather finely and sparsely punctured, a group of large punctures at each side of the anterior extremity of the short median sulcus.

Elytra but little wider (16 : 15) than the pronotum and 1.8 times as long, sides subparallel, slightly arcuate, broadly rounded behind; disc lineate-punctate, first row impressed throughout, the other only towards the base, interspaces flat, subconvex near the base, with scattered punctures, the base of the third with a few small but distinct transverse rugæ, apex strongly convex, granulate, and with short reddish pubescence.

Types in the possession of Mr. F. C. Hadden and in my collection.

LUZON, Laguna Province, Mount Maquiling, 400 feet altitude (*F. C. Hadden*).

CROSSOTARSUS FRAGMENTUS Samps.

A male specimen of the British Museum, which I would regard as a paratype,[2] I had the opportunity to see I would consider as distinct from the following male of *Crossotarsus squamulatus* Chap.

CROSSOTARSUS SQUAMULATUS Chap.

Male.—Dark brown, 5.6 mm long, 3.2 times as long as wide. Very closely allied to *C. fragmentus* Samps., but distinctly slenderer, elytra 1.77 times as long as wide, *C. fragmentus* 1.60 times as long as wide, the elytral declivity commencing farther

[2] Sharp, Coll. (1905) 303.

behind, more strongly convex, the sulci wider and the tuberculate-carinate interstice narrower, in spite of the smaller size the lateral emarginations of the declivity much larger, the lateral processes much more narrowed at the apex, the sutural emarginations narrow, much longer than wide, the lateral angles rectangular.

Front transversely depressed below, subopaque, finely areolate, densely, rather coarsely, punctured, with a depressed puncture medially.

Pronotum quadrate, median sulcus moderately long, surface shining, densely punctured, the punctures greatly varying in size.

Elytra with the fine striæ feebly impressed, the strial punctures fine.

Type in my collection.

JAVA.

Females I have seen from Malacca, Tempinis, 3–IX–1923, H. W. Woolley, in material of the British Museum and from the Malay Peninsula of the Imperial Institute of Entomology, London.

CROSSOTARSUS SEXPORUS sp. nov.

Female.—Dark reddish brown, 4.5 mm long, 3.3 times as long as wide. Closely allied to *C. koryoensis* Mur.

Front subshining, feebly convex, coarsely punctured, finely, longitudinally areolate above, gradually becoming punctured towards the vertex.

Pronotum quadrate, widest at the anterior edges of the moderately developed femoral grooves, median sulcus very long and deep, surrounded by a cordiform depressed space, which bears several small punctures and three large pores on each side, remaining surface shining and subimpunctate.

Elytra wider (14 : 13) and 2.1 times as long as the pronotum, of the same general shape and sculpture as *C. koryoensis,* but the base of the third interstice hardly elevated and without the transverse rugæ, but with a few fine punctures, the apex wider, along the suture not depressed, the apical face smaller and more transverse.

Type in my collection.

"Philippinen," without exact locality.

PLATYPUS SETACEUS Chap.

Female.—Dark reddish brown, 4.7 mm long, 3.1 times as long as wide.

Front deeply transversely concave on the anterior half, concavity shining, impunctate, the upper part abruptly elevated, convex, the lower limits triangular, densely covered with erect reddish hairs and densely punctured, rounded towards the vertex. The entire front similar to that of *P. luzonicus* m.

Pronotum quadrate, femoral grooves short and shallow, median sulcus long and fine, surrounded by a transverse oval patch of densely placed fine punctures, remaining surface finely reticulate and shallowly but coarsely punctured.

Elytra but little wider than pronotum (15: 14) and twice as long, sides parallel, feebly obliquely rounded behind, transverse at the apex; disc striate-sulcate, sulci moderately deep, punctures shallow, somewhat indistinct, interspaces feebly convex, with numerous fine punctures along the sulci, the first interspace finely granulate throughout, base of the third but little widened and densely granulate; declivity feebly convex above, perpendicular below, on the upper convexity the interstices narrow and densely granulate, opaque and subrugose below. Entire declivity with short erect pubescence.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Baguio, 1,600 meters altitude (*W. Schultze*).

PLATYPUS TENELLUS sp. nov.

Male.—Dark brown, 5.2 mm long, three times as long as wide. Similar to *P. douei* Chap., but with different sculpture of the front and the pronotum.

Front opaque, flat, sparsely but coarsely punctured and feebly transversely elevated between the articulations of the antennæ.

Pronotum quadrate, shining, femoral grooves broad and shallow, median sulcus very short, surrounded by a subquadrate patch of fine densely placed punctures, remaining surface coarsely but shallowly punctured.

Elytra wider than pronotum (17.5 : 15) and 2.2 times as long, sides straight, diverging towards the posterior third, thence rather narrowly rounded to the apex, cylindrical on the basal two-thirds, gradually declivous and convex behind; disc striate-sulcate, sulci deep but without recognizable punctures, the first interstices narrow, very finely tuberculate, the others feebly convex and with numerous punctures along the sulci, the third and fifth a little wider than the others, base of the third not noticeably widened but with some densely placed punctures; declivital convexity with similar, low, uniseriately, finely tuberculate in-

terspaces in the upper half, at the middle of the convexity with a large hornlike structure in the continuation of the third interstice, the lower part subshining, impunctate.

Female.—Female similar to the male in size and proportions, the front flat, much smoother than in the male, the puncturation very fine and sparse, with some long erect hairs. Pronotum exactly as in the male, except for the decidedly finer puncturation. The elytra with the base of the interspaces 2 to 7 finely granulate, the declivity without the large teeth but with a low elevation, which is armed with a small granule, the upper convex portion more coarsely granulate and rather densely hairy.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Mount Santo Tomas, on *Ficus* sp. and *Pinus insularis* Endl. (*W. Schultze*).

PLATYPUS LUZONICUS sp. nov.

Male.—Dark reddish brown, elytra darker, 6.5 mm long, 3.4 times as long as wide. The peculiar sculpture of the elytral disc would refer this species to the *Platypi dorso-sulcati,* but the general development of the elytral declivity and the close affinity of the female to *Platypus setaceus* Chap. indicate clearly that it belongs in the *Platypi sulcati.*

Front opaque except for the sparsely punctured epistomal margin, broadly depressed, with a median shining puncture, obtusely angulate on the vertex, the latter with three low shining carinæ, sparsely coarsely punctured and with long erect hairs.

Pronotum but little longer than wide, shining, femoral grooves hardly noticeable when viewed from above, median sulcus feebly developed, surrounded by a short oval patch of fine punctures, remaining surface shallowly but coarsely punctured and with long erect and sparse pubescence.

Elytra wider than pronotum (20 : 18.5) and twice as long, sides parallel, shortly and narrowly rounded behind, cylindrical on more than the basal two-thirds, obliquely convex behind; disc striate-sulcate, the sulci opaque and finely reticulate, appearing as depressed uniformly deep and wide striæ, the first two interspaces feebly elevated and uniseriately covered with shining tubercles throughout, the third wider, opaque, with a row of fine granules on each side close to the sulci and the base finely punc-

tured, the fourth and sixth are opaque like the first and second, but tuberculate on the apical half only, the basal half shining, punctured near the base, the fifth similar to the third, but the sculpture more feebly developed, the others shining, wide, and without any remarkable sculpture; declivity breaking off in an obtuse angle, the interspaces continued on the upper half, feebly carinate and uniseriately granulate, with a large tubercle at the fifth interspace at the commencement of the lower third of the convexity, which is opaque and irregularly covered with shining punctures.

Female.—Similar to the male in size and color, the pronotum more quadrate, the elytra slenderer.

Front deeply, transversely concave anteriorly and laterally up to the middle of the eyes, concavity shining and impunctate, convex, finely punctured and densely covered with long hairs above, the median line finely carinate, rounded towards the vertex, antennal scape very large, triangular, and with long erect hairs.

Pronotum with the sculpture as in the male, but the patch of punctures subcircular.

Elytra with the first interstice narrow finely uniseriately tuberculate, the other interstices feebly convex, shining, densely punctured along the sulci on the sides, base of the third finely tuberculate on a long narrow space; declivity more oblique, depressed on a triangular space below, the upper convexity densely granulate, the lateral margin of the depression somewhat elevated, the apex truncate.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Benguet, Mount Santo Tomas (*W. Schultze*).

PLATYPUS NOCUUS sp. nov.

Male.—Dark brown, 4 mm long, 3.7 times as long as wide. Another species of the *Platypi antennati;* similar to *P. excedens* Chap., but larger and with different sculpture of the declivity and pronotum.

Front flat, feebly depressed up to the articulation of the antennæ and along the median line up to the center, shining and coarsely punctured below, subshining and granulate-punctate above. Antennal scape wider than long and pale yellow.

Pronotum longer than wide (12 : 10), femoral grooves feebly developed, median sulcus shallow, not reaching the base, with a small elongate patch of fine densely placed punctures on each side of its anterior extremity, surface shining, finely punctured.

Elytra wider than pronotum (11.5 : 10) and twice as long, sides parallel on the basal two-thirds, narrowly rounded behind; disc finely lineate-punctate, the punctures remotely placed, interspaces polished, subimpunctate, base of interpaces 2, 3, 4, and 5 finely granulate; declivity opaque, commencing far behind the middle, feebly convex above, perpendicular below, the polished discal interspaces abruptly ceasing, but not elevated, in their continuation with rows of fine granules on the upper convexity, somewhat bluntly produced and with several granules at the middle of the declivity, a more constant granule on the second interstice of the perpendicular face.

Female.—Somewhat longer and slenderer than the male.

Front deeply concave on the anterior half, flat above, concavity polished and impunctate, upper portion irregularly punctured, median line carinate in the upper half of the concavity, shortly impressed above; antennal scape much wider than long, pale yellow, and fringed with long yellow hairs.

Pronotum in outline as in the male, median sulcus longer, surrounded by a larger patch of fine punctures, surface densely, finely reticulate, subshining, shallowly punctured.

Elytra with the sides parallel, transversely rounded behind, disc lineate-punctate, the punctures longer than in the male, the interspaces finely reticulate, the base of interspaces 2, 3, 4, and 5 more coarsely granulate; declivity feebly convex, granulate, with short yellowish pubescence.

Types in the possession of Mr. W. Schultze and in my collection.

LUZON, Mountain Province, Mount Santo Tomas, on *Ficus* sp. (*W. Schultze*).

PLATYPUS CURTUS Chap.

Female.—In size and proportions similar to the male.

Front flat, opaque, shortly pubescent, but distinctly densely punctured, the vertex with three elevated polished carinæ.

Pronotum quadrate, median sulcus short but distinct, the basal third of the punctured patch with three or four large porelike punctures on each side.

Elytra with the sides parallel beyond the middle, obliquely narrowed behind, apex transverse; disc indistinctly striate-punctate, interstices more confusedly punctured, base of the third strongly elevated, widened and transversely rugose, with a row of granules on the fourth and fifth, declivity shortly convex, perpendicular below, upper convexity densely, coarsely granulate, finely punctulate below, entire declivity opaque, and with erect dense pubescence.

Types in the possession of Mr. W. Schultze and in my collection.

NEGROS, Occidental Negros Province, Fabrica (*W. Schultze*). MINDORO, Mount Calavite (*W. Schultze*).

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CHIRONOMIDÆ FROM JAPAN (DIPTERA), IV

THE EARLY STAGES OF A MARINE MIDGE, TELMATOGETON JAPONICUS TOKUNAGA [1]

By MASAAKI TOKUNAGA

Assistant Professor in Entomology, Kyoto Imperial University, Japan

THREE PLATES AND ONE TEXT FIGURE

There have been reported seven species of the genus *Telmatogeton* Schiner; namely, *T. sanctipauli* Schiner, *T. minor* Kieffer, *T. torrenticola* Terry, *T. abnorme* Terry, *T. trochanteratum* Edwards, *T. simplicipes* Edwards, and *T. japonicus* Tokunaga; and the majority of them, excepting the two Hawaiian species, are true marine in habitat. Studies of their biology are incomplete, and I report here more details of the structures of immature forms and some ecologic observations on the last species at Tottori, Karo.

These studies were made under the direction of Prof. Dr. Hachiro Yuasa, who has my hearty thanks. I am also deeply indebted to Prof. Dr. K. Okada for the use of equipment at the Seto Marine Biological Laboratory of the Kyoto Imperial University.

ECOLOGIC REMARKS

The size of this fly seems to vary in different localities. Specimens collected on the coast of the Pacific Ocean, at Wakayama, Seto, in June, 1930, are small, measuring 2.5 to 3 mm in length in the imaginal stage and 5 to 6 mm in the full-grown larval stage; while those obtained on the coast of the Japan Sea, at Tottori, Karo Harbor, in July, 1931, are large, being 4 to 4.5 mm in the adult form, 5.9 to 6.8 mm in the pupal stage, and 9 to 10 mm in the full-grown larval condition. These differences in size are probably due to the different conditions of the algal food rather than to the different localities themselves. The small specimens were found on the algal breeding bed composed

[1] Contribution from the entomological laboratory of Kyoto Imperial University, No. 43. Contribution from the Seto Marine Biological Laboratory of Kyoto Imperial University.

of *Monostroma* sp. on the ordinary tidal zone of a rocky shore, where this alga was very much damaged and faded, already being covered by shore sand at this season. The large specimens were taken from a breeding bed consisting of *Ulva pertusa* on stones at the estuary, and at this season the growth of this alga was still luxuriant. In the spring of 1934 I visited Seto again and obtained many vernal forms. These specimens are far larger than the summer forms of the same locality, being as large as the specimens at Karo; they were colonizing on *Monostroma* sp., which was most luxuriant in this season. The sexual difference in size is little and obscure.

Both sexes are nocturnal in habit, being most active in the evening about three hours after sunset, and imagines are usually resting in the daytime on the shaded side of a rock. Occasionally on a cloudy day, and rarely even in the direct sunshine, some individuals are actively scampering and ovipositing. When the fly is at rest, the body is closely applied to the substratum with the six long legs outstretched, as in the crane flies, supporting the body with only two distal joints of each tarsus. When the fly rests on a plain surface, either horizontal or vertical, the angles between the legs are as follows: 33° between the forelegs, 59° between the fore and middle legs, and 75° between the middle and hind legs.

The imagines rarely take flight unless molested, mating and swarming taking place only on the rock surface, and when disturbed by the on-coming waves, they adroitly fly up momentarily and resume active scampering and oviposition as soon as the waves recede. Thus they usually are found about their breeding place, but they can fly for some distance. On a calm evening, from 8 to 10.20 p. m., six female and seven male adults were obtained at a light screen set at about 600 meters from the habitat of this fly.

In size, shape, color, and structure the eggs closely resemble those of the related genus *Paraclunio* observed by Saunders. The female, soon after emergence, contains 150 to 190 mature eggs (168 mean for 20 flies), and they are almost all laid during the life of the fly. The eggs are placed singly in small crevices or pits of rock surface, as in *Paraclunio alaskensis* Coquillet, and never laid in a mass or single layer on the smooth surface as in the fresh-water species *Telmatogeton torrenticola* Terry. During oviposition, as in the marine crane fly *Limonia* (*Dicranomyia*) *trifilamentosa* Alexander, the female inserts the ovi-

positor into a crevice and flutters the wings by a rapid bobbing motion. The surface where the eggs are laid is never dry.

The adult females and males are attracted to light, and the number collected of each sex is subequal. The females collected at light had almost completed oviposition; ten flies contained mature eggs as follows: 0, 0, 0, 0, 0, 1, 1, 2, 2, 18. This is different from the observations on certain marine flies, such as *Tanytarsus boodleæ* Tokunaga and *Limonia monostromia* Tokunaga, studied at the Seto Marine Biological Laboratory by M. N. Omori and by myself.

The larval quarter of this species is never under the low tidal mark or in the rock pool but confined to the tidal zone between the upper and lower tidal lines, as already stated by Hesse and by myself. The nest cases of the immature forms are usually single and built under individual algæ. The nest is tubelike, firm, consists of sand particles and silky threads, and is not provided with special lids at both ends. The last is true even of the pupal nest. The entire larval body is inclosed within the tube, thus differing from *T. sanctipauli* and *T. minor*. Molting and pupation take place in the original larval nest case. Before pupation the nest is thickened by additional sand particles gathered by the prepupal larva. In the early stages the larvæ, in building their loose nest cases, often utilize the natural tunnellike folds in the algal fronds, and often migrate about in the wet condition of the quarter. In the later stages, after the second stadium, the position of the nests on the rock surface is limited to the bases of the algæ, contrary to the observations of Hesse, and the larva rarely creeps out of the nest case even in the wet or submerged condition. The direction of the nest tube seems to be irregular and not related to the shape of the algal base or to the inclination of the substratum (text fig. 1).

The food found in the larval stomach consists of many fragments of the living alga and a small quantity of the dead alga, mingled with sand particles and sedentary diatoms. Thus the main food item seems to be the living algæ used for their shelter, as in the African *Telmatogeton* species, which live on *Porphyra capensis* and *P. vulgaris;* and the greenish brown appearance of the living larvæ is due to these living algal fragments contained in the stomach. The tidal rhythm often affects the feeding habit of marine insects, as I have pointed out in the case of certain marine crane flies, but the larvæ of this fly seem to show no distinct rhythmic habit in feeding, due probably to the

fact that the larvæ continue to take food in the wet condition, even after the recession of the tide.

One of the distinct effects of the tidal rhythm is shown in the emergence of the imagines. The emergence of this fly never occurs in the floating condition as among the Chironomidæ in general or in the submerged condition as among the Simuliidæ and the Blepharoceridæ in general, but takes place only in the exposed condition in the ebb tide. In the field, pupal exuviæ always remain in the pupal cases as in the hygropetric midges. The emergence commences immediately after the tide has receded and lasts to the next flood tide. When the mature pupæ are artificially submerged in the water at the period of emergence they all die in various states of the process of the emergence. The periodicity of the emergence is shown only in the natural condition, and not retained long but easily disturbed in the ever-exposed condition. The duration of the pupal period observed in the laboratory in summer is about 2.5 days, varying much in different individuals, from 47 to 72 hours, the mean duration for ten pupæ being 56.7 hours. This length of the pupal period is far less than that of *T. sanctipauli* obtained by Hesse, who recorded 4 to 7 days or more in the laboratory. The process of emergence of the female was observed in the laboratory, from which the following data were obtained:

Process of emergence in the laboratory at 5 p. m., July 5.

	Min.	sec.
Pupal thorax wriggled out from alga	2	00
Abdominal tip shore silvery	7	00
Entire body shone silvery	16	00
Imaginal abdomen began to move irregularly within the pupal skin	16	30
Middorsal suture split in T-shape	17	00
Complete emergence	17	55
Walked slowly and rested quietly	18	00
Meconium dropped down	18	45
Suddenly scampered about with fluttering wings	18	45
Rested quietly	19	30
Actively scampered about	19	50
Taken on the wing	20	00
Body normally tinged	35	00
Total process	33	00

In the field this process is usually completed in about thirty minutes. The pale imagines soon after emergence are also active in swarming, mating, and scampering, like the old dark flies, but oviposition is not shown by these young females. The turning of the male hypopygium is already exhibited within the pupal skin before the emergence, and occurs in the irregular movement at the shining stage of the pupal skin. The seasonal emergence of this fly is not so distinct as in the marine genus *Clunio,* imagines being found almost throughout the spring and summer seasons, and the growth of the larvæ collected from one colony in the same season is also very irregular. On this point Hesse stated that "there is reason to believe that there is more than one generation in a year," and judging from my observations there may be two generations in a year, imagines emerging twice, in the spring and summer seasons.

The duration of the imaginal life of imagines that were reared in the laboratory was about 20 hours in both sexes and the following data were obtained: 17, 22, and 22 hours in the female and 20 in the male. These flies in the laboratory did not show copulation or oviposition. Honey water was given them for food. This fly always colonizes on the hard substratum between the tide marks, and only three species of littoral green algæ are known as the host plants; namely, *Enteromorpha compressa, Ulva pertusa,* and *Monostroma* sp. Moreover, the rock surface where the colonization is settled always shows a sharp slope toward the water and is kept clean, as the débris, drift, and sand washed up by waves and in the ebb-tide water are not retained, as in the case of the algal bed of *Enteromorpha intestinalis.* The last-mentioned alga is one of the most prevalent plants found in a similar condition on the tidal zone to the above littoral species of algæ, and various shore chironomids and crane flies, but not *T. japonicus,* have been reported from this alga. From observations at Karo, the main animals associated with this marine midge showing a close spatial relation to the same littoral alga, *Ulva pertusa,* are one of the Janiridæ (Isopoda) and a species of *Orchestia* (Amphipoda) (text fig. 1).[2]

[2] These animals were kindly determined by Dr. K. Stephensen and Dr. K. Akatsuka, respectively.

A census of these animals on the rock surface having the largest population of *T. japonicus* is given in Table 1.

TABLE 1.—*Population of the biotic elements on the rock having the largest population of Telmatogeton japonicus Tokunaga, observed in July, 1931.*

Biotic element.	Individuals per square meter.	
		Per cent.
Telmatogeton japonicus	1,470–1,660	28.18–29.38
Pupæ	550– 560	9.51–10.99
Larvæ	920–1,100	18.39–18.68
Amphipoda	640– 650	11.04–12.78
Isopoda	1,800–1,900	32.26–35.97
Ulva pertusa	1,670–1,680	28.52–33.37

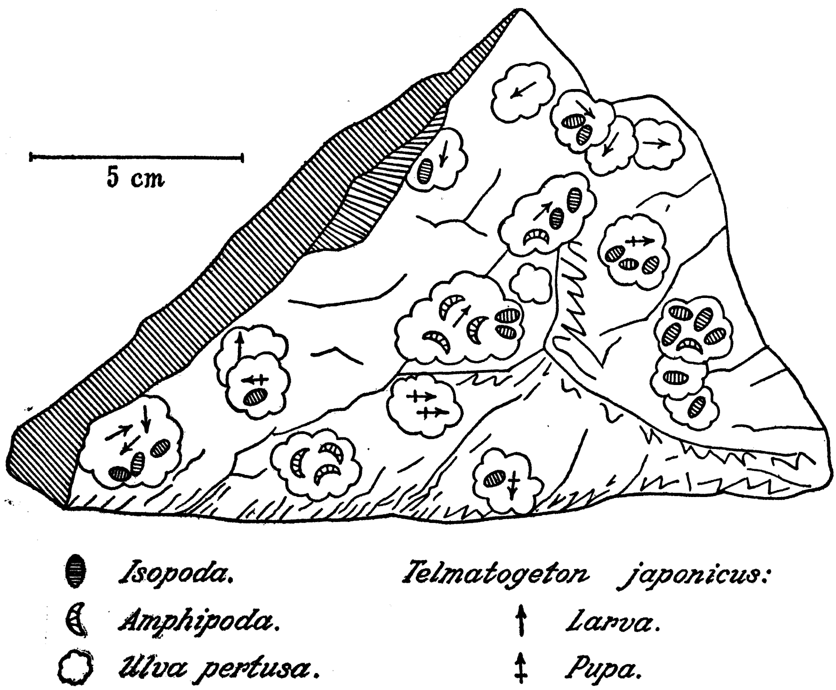

FIG. 1. Distribution of various littoral animals associated with the green alga on the surface of a piece of stone that shows a high population of the insect *Telmatogeton japonicus* Tokunaga.

It may be worth noting that the colonization of the Japanese species is found in various conditions of salinity, such as about 3.2 per cent salt (NaCl) on the Pacific coast and about 1 to 3.1 per cent on the coast of the Japan Sea, as I have already re-

ported (1933). Experimentally a dozen or more normal imagines were obtained, which were reared with fresh water alone from young second and third instars (1932 and 1933). Hesse also reported that "immersion in fresh water or sea water does not appear to affect them in any way and one specimen was left in fresh water for several days without showing any signs of being uncomfortable." Judging from these biologic observations, together with those on the Hawaiian fresh-water species, the genus *Telmatogeton* is thought to suggest a transitional mode of life between land and sea, both in habitat on the intermediate shore zone and in physiologic resistance to the salinity of sea water, differing from the other genera of the marine subfamily Clunioninæ in the latter point.

MORPHOLOGY OF THE LARVA

GENERAL REMARKS

The larva is elongated and cylindrical, of the usual chironomid type, and closely resembles that of *Paraclunio*. The body is semihyaline and pale green or greenish brown according to the algal color of the stomach contents. The development of the setæ of the body is very poor. The head is brown, darker along the occipital foramen, cephalic margin, lateral margins of the front, and at the base of the mentum. Distinct paired eyespots are present on the cephalolateral side of the vertex and each eyespot consists of closely situated masses of pigment; namely, a large posterior mass and two or three small anterior pigment masses. Terry states that these eyespots are wanting in *T. torrenticola*. The mandibles are provided with seven teeth, while in *T. torrenticola*, *T. sanctipauli*, *T. minor*, and *Paraclunio alaskensis* they are provided with five teeth, and the setæ of the brustia also differ in number from those of *T. japonicus*. The general shape of the mentum is related to that of *P. alaskensis*, and the number of teeth is nearly the same as in *T. sanctipauli*, but the shapes of the teeth are quite characteristic for the species. In the present larva there are eleven teeth, and the median tooth is comparatively small and sharply pointed, while in *T. sanctipauli* the number of the teeth varies between nine and eleven, and the middle tooth is very large; in *T. minor* it varies between eleven and thirteen, and the middle tooth is not sharp; in *T. torrenticola* there are fifteen. Both the pre- and postclypeus are well developed and the frontoclypeal suture

is straight in the present insect, while in *P. alaskensis* this suture is U-shaped, judging from Saunders's figure. The details of the antennæ, maxillæ, and epipharynx are quite characteristic for this species. The salivary glands are asymmetrical as pointed out by Saunders in the case of *P. alaskensis,* the left being divided into two equal, long, tubular glands and the right being single with a round basal lobe. Moreover, each caudal tuft of the terminal segment of the Japanese species is represented only by two single setæ arising directly from the skin, while in the African species these setæ arise from a common base.

THE HEAD CAPSULE

The head capsule is broad, compact, highly chitinized, and nonretractile. The entire surface of the head is finely sculptured. This sculpture is the structure of the ental surface of the cuticular layer, and the external surface is quite smooth. The reticulation on the ventral side is more compact and complete than on the dorsal side. Along the thickened occipital foramen there are large, hyaline, mussel-shaped, paired ental lamellæ, which serve as the attachments of the strong cervical muscles. The head capsule is divisible into paired lateral halves of the vertex and the unpaired sclerite of the front by the distinct epicranial suture and the midventral suture. The former suture is split in the process of molting and pupation.

The vertex (Plate 2, figs. 7 and 8) is provided with two pairs of small sensory pores on the dorsocaudal surface, a pair on the lateral side, a pair on the dorsal side near the basis of the mentum, and a pair on the dorsocephalic part near the front. Simple setæ are also found on the vertex; a pair on the dorsal part near the front, a pair on the laterocephalic part, and a pair on the ventrocephalic region near the bases of the postcoilæ. The ventrocephalic margin of the vertex is strongly projected cephalad, forming a distinct postcoila, and on the dorsal side the cephalic margin is also projected ventrocephalad, forming a blunt precoila for the articulation of the mandible.

The front (Plate 2, fig. 7) is broad, shield-shaped, and somewhat oval. Two pairs of simple setæ are found on the laterocephalic margins along the epicranial arms.

The antennæ (Plate 2, fig. 9) are located close to the clypeus. The antennaria is well developed, subtriangular, and thickly chitinized, but not developed externally. The major part of the antennaria is displaced caudad under the vertex along the

epicranial arm. Thus the vertex on this region appears to be of a dark color due to the thick chitinization of the antennaria, and the external distal region of the antennaria is shown as a tubercle between the clypealia and precoila in the dorsal aspect. The antenna (Plate 2, fig. 7) is articulated to the cephalic end of the antennaria by means of the intermediation of the large socketlike antacoria. The antenna is very small for the size of the head capsule and 4-segmented. The proximal segment is comparatively large, not cylindrical but somewhat barrel-shaped, its length about twice its width or the length of the remaining three segments taken together, provided with a sensory pore on the dorsoproximal region, and membranous on its distal end. In some cases it appears that there is a very delicate hyaline seta on the base of this segment, but this is not determined yet to be constantly present. The second antennal segment is cylindrical and twice as long as wide. On the distal membrane of the proximal segment, in a parallel position with the second segment, there is a membranous trichoid sensilla, Lauterborn's organ, which is as long as the distal three segments taken together and biramous on its distal region as in *T. torrenticola*. The distal two segments are very minute and brown. Besides these segments, on the distal membrane of the second segment there are a chitinized sensory peg and two tricoid hyaline sensillæ, which are all as long as the distal two segments taken together. The segments of the antenna are often incorrectly counted as three owing to the extremely delicate structures of the distal region of the antenna and to the presence of the comparatively large sensory peg, which is brown and as long as the two distal segments of the antenna proper taken together.

THE MOUTH PARTS

The mouth opening is large and provided with a well-developed labrum, epipharynx, mandibles, mentum, and hypopharynx. The maxillæ are small, and the labial appendages are all atrophied.

The clypeolabrum (Plate 2, figs. 7, 8, and 10) is somewhat trapezoid and composed of the thickly chitinized marginal structures and two chitinized plates, pre- and postclypeus, on the membrane. The region of the postclypeus is demarcated from the front by the straight frontoclypeal suture and from the preclypeus by the shallow fold of the membrane and consists

of a trapezoid plate, postclypeus proper, and the lateral membrane. The chitinized plate is not provided with setæ, but on the lateral membrane there is a very large seta, which grows on the conspicuous tubercle. The preclypeus is obscurely demarcated from the labrum by a pair of incomplete furrows on the lateral membrane of the clypeolabrum and provided with a subtriangular plate, preclypeus proper, on its meson and a pair of ordinary setæ on its lateral membrane. The labrum is membranous, provided with a pair of simple setæ on its dorsal side, and various cuticular appendages on its cephalic smooth membrane, which is somewhat dilated ventrad. On this swollen area, as shown in Plate 2, fig. 10, giving the cephalic aspect of the labrum, there are paired brushlike setal groups on the lateral sides, three pairs of hyaline trichoid sensillæ, which are curved ventrocaudad on the meson, two pairs of sensory pegs on the dorsomeson, and two pairs of minute hyaline trichoid sensillæ, which are extended mesad and located near the sensory pegs. On the entire dorsal membrane of the clypeolabrum minute round dots of chitinization are densely arranged. Each dot represents the external surface of the conical tuberclelike chitinization of the cuticular layer, which is internally thickened.

The lateral chitinization of the clypeolabrum consists of three different sclerites in the typical specimen, two of which are homologous with the clypealia and torma. The remaining one is apt to be overlooked, but this chitinization is widely shown in Nematocera, and the origin is considered as the secondary chitinization of the lateral margins of the labrum, for which I propose the term "labralia." In the present case the clypealiæ are well developed and found on the lateroproximal margins of the clypeolabrum. The tormæ are firmly fused with the labraliæ and represented by the blunt ventral projections. The labraliæ are fused with each other at the cephalic extremity, forming a framework to support the labral membrane, and on the ventral side these marginal sclerites bluntly project mesad for the articulation of the premandibles.

Although the ventral side of the clypeolabrum (Plate 2, figs. 8 and 10) is not definitely divided into the epipharynx and epigusta, the region of the epigusta is quite smooth and membranous, while the region of the epipharynx is provided with various appendages that are characteristic for the chironomid larvæ. Of these appendages the most conspicuous organs are

the paired premandibles, which are articulated to the special projections of the labraliæ, each provided with a set of antagonistic muscles at its basal projections. The distal half of the premandibles is thin, somewhat concave on the mesal aspect, and dentated into three blunt teeth on its edge, as in Plate 2, fig. 12. The membrane mesad of the premandibles is swollen and spinous. On the cephalic region of the epipharynx there is a U-shaped chitinization, which is formed by the fusion of originally paired secondary chitinization of the membrane. Along the arms of this U-shaped structure there are paired groups of minute hooklets. These hooklets (Plate 2, fig. 11) are hyaline and flat, and those of the mesal side are finely serrated, while those of the lateral side are simple and slender. On the cephalic margin of the epipharynx there are three minute, hyaline, scalelike combs, which are finely and irregularly serrated on the distal margin. Besides these cuticular structures there is a pair of brown thickened patches on the meson caudad of the U-shaped sclerite or mesad of the premandibles.

The mandibles (Plate 2, figs. 8, 13, and 14) are symmetrical in structure, comparatively slender, and each has two long setæ on the ventrolateral surface. There are seven mandibular teeth. The distadentis is somewhat slenderer than the proxadentes, but there is no distinct differentiation between them. At the base of the dental row is a strong hyaline seta. The brustia is represented only by a proximal group of simple setæ, which are on the membranous area at the attachment of the retractotendon, and the number of setæ is usually six. The extensotendon is slender, but the retractotendon is very large, thickly chitinized, and oval.

The maxilla (Plate 2, fig. 8; Plate 3, figs. 16 and 17) is membranous, connected with the ventrocephalic margin of the vertex by the broad maxacoria, and consists of two chitinized plates and two blunt distal membranous lobes. These two sclerites are the cardo and the stipes. The stipes is reduced into a small elongated sclerite on the dorsal side of the maxilla at the base of the lateral membranous lobe, and the ventral part of the stipes is reduced completely. The cardo is large, located on the ventral side, and its mesal part is bent dorsolaterad. Thus, as the result of the reduction of the stipes, the inner membranous lobe is directly supported by the semicircular cardo at its base.

The inner lobe is the lacinia. This membranous projection is subtriangular, thickly fringed with special setæ; the setæ on the cephalic margin are delicate and slender (Plate 3, fig. 16, *c*), and those on the mesal margin are long, stiff, semihyaline, and somewhat swollen at the base (Plate 3, fig. 16, *d*). On the ventral surface there are two long ordinary sensory setæ, and on the dorsal surface there is a group of sensory pegs (Plate 3, fig. 16, *b*).

The lateral lobe is the palpifer. The ventral surface of the palpifer is thinly membranous, very finely pubescent, provided with two long ordinary setæ on the basal region, which are located on the common basal chitinization, and with two sensory setæ on the meson, which are flat, somewhat blade-shaped, and each is attached to the individual tubercle (Plate 3, fig. 16, *e*). The dorsal surface is covered with the small pale brown scale-like structure that is shown in Plate 3, fig. 16, *a*. The maxillary palpus (Plate 3, figs. 17 and 18) is small and nonsegmented, located in the socketlike membranous concavity on the distal region of the palpifer. On the distal membrane of the maxillary palpus are usually eight minute sensillæ, as shown in Plate 3, fig. 18.

The labium is represented only by the dentated mentum, completely losing its palpi and membranous structures as is generally the case in the Chironomidæ. The mentum (Plate 2, fig. 8) is broad, thickly chitinized, with eleven teeth, including the large median and a pair of the most-lateral minute teeth. The setæ are wanting. The submentum, which is usually known as the fanlike lobe, is completely atrophied.

The hypopharyngeal structures (Plate 3, fig. 15) are comparatively well developed. The dorsal surface of the hypopharynx is membranous and provided with numerous spines, which are directed backwards. The lateral sides of the hypopharynx are supported by a pair of elongated sclerites, pharyngea-lingulæ, which are provided with two tendons on each caudal end that may be homologous with the linguacuta and paralingua tendon, being the pharyngea tendon atrophied. The salivos is found between the cephalic ends of the pharyngea-lingulæ and supported by the salivia. The salivia consists of two thinly chitinized plates; the dorsal plate is broad, while the ventral is narrow, and the two plates are directly connected with the cephalic ends of the pharyngea-lingulæ on their lateral corners.

The common salivary duct is comparatively short and distinctly dilated before the aperture. The ventral side of the hypopharynx is represented by the ventral plate of the salivia, which is connected with the dorsal side of the mentum by a narrow, delicate, membranous oscula. The special structure composed of the setæ is connected with the ventral plate of the salivia. The setæ of this structure are featherlike, stiff, pale brown, finely serrated on the lateral sides, more or less curved dorsad (Plate 3, fig. 15, *f*), and arranged in five or six rows. The small setæ are arranged on the dorsocaudal region, and the majority of the long setæ are located on the membranous areas near the lateral sides of the ventral plate of the salivia.

THE THORAX AND THE ABDOMEN

Of the three thoracic segments the prothorax is large and the remaining two segments are very small, being smaller than those of the abdomen except for the ultimate one. The setæ are very poorly developed and the great majority of them are very delicate and slender. The distribution of the setæ on the prothorax is somewhat different from that of the following two segments. On the prothorax three pairs of minute setæ are found on the anterior region of the tergum near the cervacoria and two pairs on the sternum near the base of the pseudopods. Of the lateral pairs one pair is long and comparatively distinct, and each consists of two ordinary setæ. On each of the remaining thoracic segments one minute seta is found on the anterior region of the lateral fold and three pairs on the sternum, and often some of these setæ consist of double setæ. The anterior pseudopods are quite contiguous, being incompletely separated by the shallow furrow and provided with numerous, simple, small brown hooklets on the distal region, but on the median furrow the hooklets are quite wanting. These hooklets are arranged on the oval area on each pseudopod, and the majority of them are very minute, but those of the anterior margin are long and slender.

The setæ on the abdomen are also very poorly developed and their distribution is subequal to each of the abdominal segments except for the two posterior ones. Generally, on the abdominal segment, there are two pairs on the tergum of which the anterior is large, a long single seta on the posterior region of the lateral fold, two pairs on the sternum of which the posterior is distinct,

and two simple setæ on the lateral side of the sternum close to the lateral fold. On the ninth abdominal segment there are two pairs of conspicuous setal groups on the posterior region of the tergum. Each setal group consists of two long stiff ordinary setæ growing from a common basal ring not provided with a common basal tubercle, differing in this from most species of the Chironomidæ. These caudal setæ are thought to be inconspicuous in certain related species, judging from the figures given by Johannsen and Saunders. The sternum of the ninth segment usually is not provided with setæ, but in the male on the meson of the sternum there is a slight furrow, which indicates the rudiment of the genital aperture, and in the female the genital rudiment is found between the eighth and ninth sterna. The ultimate segment is very small; there is one pair of ordinary setæ on the posterior region of the tergum and a single seta on the lateral side. The posterior pseudopods are comparatively short, but strong, deeply separated from each other, and each is provided with nineteen chitinized hooks on its distal region. These hooks are various in size, not serrated but all simple, arranged into about three circular rows on the distal end, and those of the peripheral rows are smaller and more sharply curved than those of the inner rows. The anal and caudolateral gills are all wanting as in the marine forms in general.

MORPHOLOGY OF THE PUPA

GENERAL REMARKS

The pupa is cylindrical, and both ends are obliquely truncated and more or less flattened. These oblique surfaces of the extremities are more thickened than in the other parts. In all probability these structures mainly serve for the protection of the quiescent pupa in the open cylindrical nest case. Especially, the peculiar abdominal termination is thought to serve partially to avert the danger of the pupa being washed away from the unclosed nest by waves, together with the small paired hooks provided on the ventral side of the caudal extremity, besides serving as a piston in the tube to force the pupa out to the surface when it is ready to emerge, as suggested by Saunders. Terry described this terminal structure as a suckerlike structure, but Saunders said that no such function can be ascribed to it.

Although neither Terry nor Saunders has mentioned it, in both sexes of the present species there is a pair of small but distinct hooks on the ventrocaudal side of the anal disc, as in *T. sanctipauli* and *T. minor*. This chitinized anal disc is thought to be an obvious character for the group including *Telmatogeton* and *Paraclunio*, differing from the group including *Clunio*, although the immature forms of the other genera of the Clunioninæ are little known.

The coloration of the pupa differs with the stage of development; in the early stage it is pale yellowish and semihyaline, darkening gradually on the anal disc, head, thorax, wings, and legs, and before the emergence the entire body appears dark brown. The pupal exuvia is pale brown on the head, thorax, anal disc, and sheaths of wings and legs and quite hyaline on the abdomen. The sexual difference is shown only on the genital sheaths; on the other structures it is very obscure.

In comparison with the other known pupal forms of *Telmatogeton*, the following structures of *T. japonicus* may be pointed out as the distinct differences: Head not distinctly bilobate apically, abdominal segments not provided with the anterior transverse shagreened bands, first abdominal segment without the paired lateral lobelike prominences, differing in this character from *T. sanctipauli*, anal disc of the female not distinctly elongated, differing in this from *T. minor* and *T. sanctipauli*, and prothoracic respiratory organ characteristic in shape for the species.

THE HEAD

The head (Plate 1, figs. 1 to 3) is comparatively broad, flattened and rugous on its surface, and situated on the ventrocephalic end of the body.

The sheaths of the antennæ are small, arising from the cephalic margin of the head, extending along the cephalic margin of the head but not far beyond the middle of the lateral margin of the vertex, and the sheaths are shallowly constricted according to the segmentation of the adult antennæ. On the dorsal side at the base of the antennal sheaths is a pair of conspicuous setæ, and there is a pair of minute papilliform projections on the dorsomeson of the head.

The ventral surface of the head is divided by the shallowly depressed epicranial suture into the lateral halves of the vertex

and the median frontoclypeus. This epicranial suture is never split in the process of emergence, and the imaginal head comes out through the cervical opening in this species. The area of the compound eye is very large, somewhat reniform, and hyaline in the exuvia. There is a pair of small setæ on the caudal side of the vertex. The frontoclypeus is large, somewhat triangular, and devoid of sensory and ordinary setæ.

The labral sheath is small; the labial sheaths are minute and separated from each other. The sheaths of the maxillary palpi are comparatively large for the small adult palpi, closely extended along the caudal margin of the vertex, and reach as far as the lateral margin of the head.

THE THORAX

The cephalic half of the thorax in height suddenly decreases forwards. The middorsal suture is distinctly marked throughout the prothorax, præscutum, scutum, and scutellum. This suture and a transversal suture of the cervacoria, which is shown by a chained line in Plate 1, fig. 2, are split in the process of emergence. The thoracic appendages are tightly held close to the ventral side of the body. The lateral margin of the thorax, cephalad of the wing base, is distinctly folded ventrad, forming a thickly chitinized ridge.

The prothorax is not distinctly demarcated from the mesopræscutum, and on its meson it seems to be separated into triangular lateral halves by the prolonged præscutum in the dorsal aspect. On the lateral margin of the pronotum is a pair of broad, flattened, ax-shaped, respiratory horns. The horns are closely similar in shape and structure to those of *P. alaskensis* described by Saunders. The tracheal trunk within a horn is dark brown, distinctly dilated, cylindrical, and slightly constricted before the opening. The opening is cuplike, provided with a dark ring and fringed processes of the lip, which are radially arranged. On the dorsal side near the base of the prothoracic respiratory horn there is usually an isolated seta and two closely arranged setæ.

The dorsum of the mesothorax consists of the scutopræscutum, scutellum, and postscutellum. The former two regions are rugous and indistinctly separated from each other by an incomplete shallow depression, but the last region is distinctly demarcated by a deep transversal furrow and quite smooth.

On the posterior part of the scutopræscutum there are two pairs of minute and a pair of distinct setæ, which are arranged transversally before the scutellum. A single distinct seta is found in the position corresponding with the adult prealar setæ. The scutellum and postscutellum are devoid of setæ. Between the postscutellum and the base of the wing the parascutella is partially visible in the dorsal aspect. The dorsum of the metathorax is not visible externally, being deeply hidden within the invagination between the thorax and abdomen.

The sheaths of the wings are extended ventrocaudad close along the body, ending before the caudal margin of the second abdominal sternum, and the distance between the tips of the wing sheaths is comparatively short. The anal angle of the wing sheath is well developed and the tip of the sheath comparatively sharp.

The sheaths of the legs do not extend caudad beyond the caudal margin of the second abdominal sternum as in the wing sheaths. The major parts of the paired sheaths of the fore and middle legs, including the tibiæ and tarsi, are extended caudomesad, forming a V, but not closely contiguous on their distal regions. Moreover, the sheaths of the fore and middle legs on one side are arranged in parallel position. The foreleg sheath is extended along the cephalic margin of the wing sheath and entirely visible in the ventral aspect, while the tarsal region of the middle-leg sheath is hidden under the wing sheath and ended before the tip of the foreleg sheath. The major part of the hind-leg sheath is not visible externally, being hidden under the preceding legs and wing. Under the wing sheath the hind leg is turned thrice, ending near the tip of the wing sheath, and the distal three tarsal joints of the hind leg are arranged along the caudal margin of the wing sheath and externally visible.

THE ABDOMEN

The cephalic seven segments are normal in type and subequal in shape and structure to each other, while the remaining terminal segments are highly modified for the genital sheaths and anal disc.

Generally an abdominal segment is provided with a U-shaped marginal chitinization each on the tergum and sternum, paired pale brown spinous patches on the lateral sides near the ends of the arms of the U-shaped chitinization, and several delicate

minute setæ. The arrangement of the setæ is as follows: Two pairs on the dorsocephalic region, one pair on the dorsocaudal, one pair on the ventrocephalic, two pairs on the ventrocaudal region, and on the lateral side two setæ on the cephalic region and a single seta on the caudal region. The first, second, third, and seventh segments are somewhat different in these cuticular structures. The ventral U-shaped chitinization is not present on the cephalic two sterna; the dorsal U-shaped chitinization is widely interrupted on the meson of the first tergum by the intruding postscutellum, being represented by a pair of separate lateral arms; the ventral chitinization of the third segment is also interrupted slightly by the special large, brown, oval, spinous patch; the setæ on the dorsocaudal region are usually wanting on the first and seventh segments, and the small, spinous, lateral patches are wanting on the first, second, and seventh abdominal segments.

The anal disc (Plate 1, fig. 5) is oval, more pointed on its caudal region in the female than in the male, thickly chitinized, composed of roughened chitin corrugated along the margin, and divisible into two parts by a deep furrow. These two parts are slightly movable along this furrow, and they are held at a different angle to the body axis, the upper part being almost perpendicular and the lower distinctly oblique (Plate 1, fig. 3). The upper part is lunate. The convex margin is heavily thickened, irregularly dentated into strong spines, and usually provided with two pairs of strong setæ. The surface of this region is distinctly roughened by numerous minute depressed dots and provided with two small setæ along its margin. The lower part is large and fringed with a row of slender setæ on its thickened margin. The dorsal surface of this part is very slightly elevated caudad on the meson, entirely covered with minute spines, and provided with small, strong, scattered spines, U-shaped brown markings on the meson, and two pairs of large and small setæ on the depressed areas. On the ventral side there are many large setæ, which are attached to the tubercles on the marginal area, and a pair of strong hooks on the caudal end, curved cephaloventrad.

The terminal segment just before the anal disc is very narrow, especially on the tergum, and provided with several slender setæ on the ventrocaudal margin, and in the male pupal exuvia there is a brown marking on the ventrocephalic area, as shown

in Plate 1, fig. 4. The sheaths of the genital structures are on the ventral side of the anal disc. In the female the genital sheaths are pointed (Plate 1, fig. 1) and in the male blunt (Plate 1, fig. 4). In the female the sheaths of the ovipositor are very small, provided with about four small setæ on the base, and the paired sheaths are contiguous, forming a double-headed papilliform projection at the caudal end. The sheaths of the cerci are also quite contiguous with each other, forming a large common lobe, which is devoid of setæ. In the male the sheaths of the claspers are comparatively large, forming a pentagonal common lobe, which is deeply depressed on the meson and devoid of setæ.

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ILLUSTRATIONS

[Drawings by M. Tokunaga.]

TELMATOGETON JAPONICUS TOKUNAGA

PLATE 1

FIG. 1. Female pupa, ventral aspect.
2. Female pupa, dorsal aspect.
3. Female pupa, lateral aspect.
4. Male pupa, genital sheath, ventral aspect.
5. Male pupa, anal disc, caudal aspect.

PLATE 2

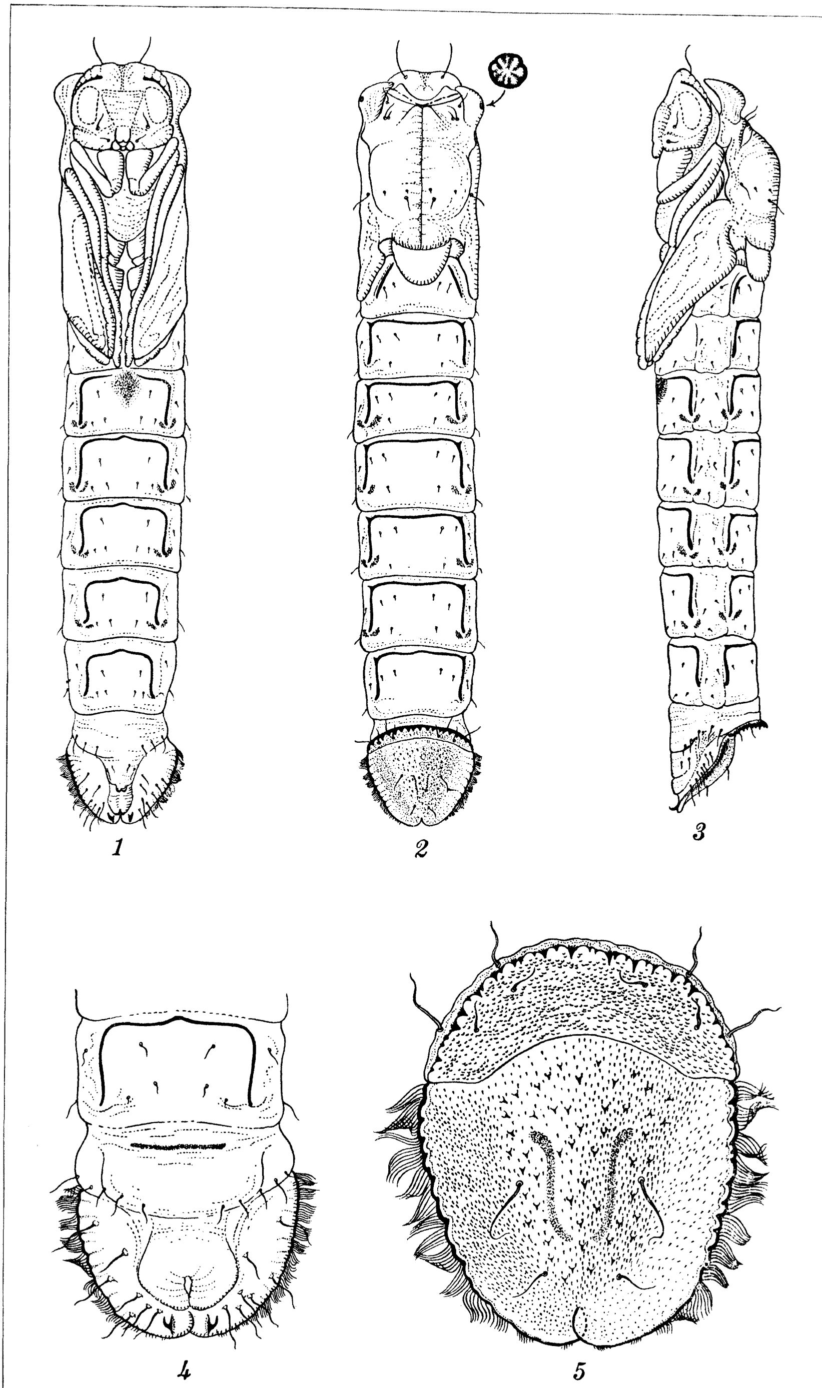
FIG. 6. Full-grown larva, lateral aspect.
7. Larval head capsule, dorsal aspect.
8. Larval head capsule, ventral aspect.
9. Larval antenna, lateral aspect.
10. Larval labrum-epipharynx, cephalic aspect.
11. Various hooklets of larval epipharynx.
12. Premandible, mesal aspect.

PLATE 3

FIG. 13. Sinistral larval mandible, dorsal aspect.
14. Sinistral larval mandible, ventral aspect.
15. Larval hypopharynx, dorsal aspect; *f*, featherlike setæ of hypopharynx.
16. Sinistral larval maxilla, dorsal aspect.
17. Sinistral larval maxilla, ventral aspect; *a* to *e*, various cuticular structures.
18. Larval maxillary palpus.

TEXT FIGURE

FIG. 1. Distribution of various littoral animals associated with the green alga on the surface of a piece of stone that shows a high population of the insect *Telmatogeton japonicus* Tokunaga.



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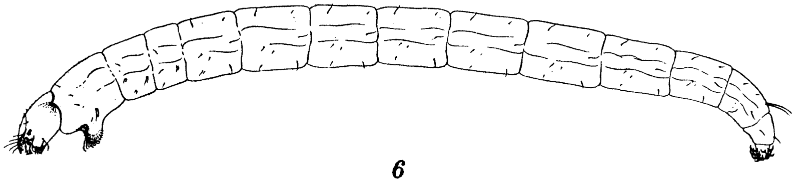
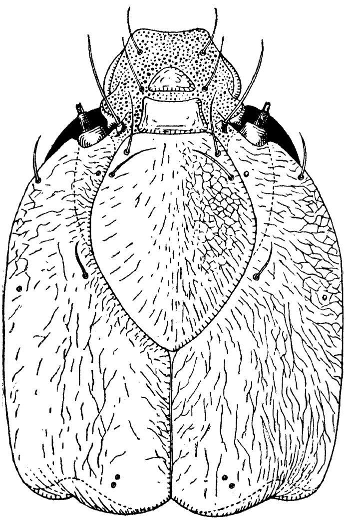


6



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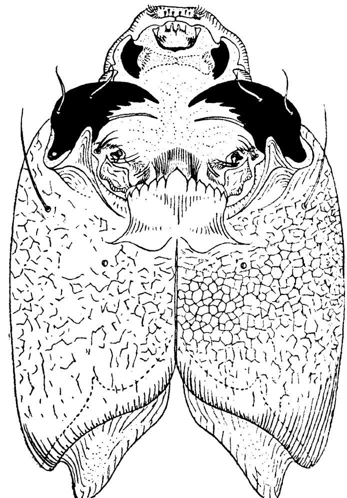

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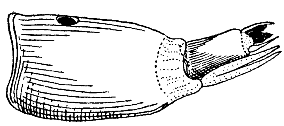
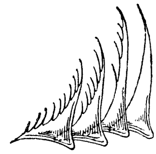
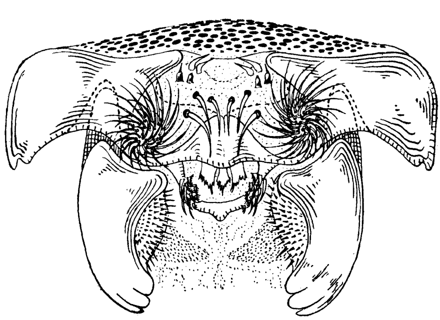


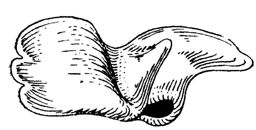
9



11



10



12

PLATE 2.

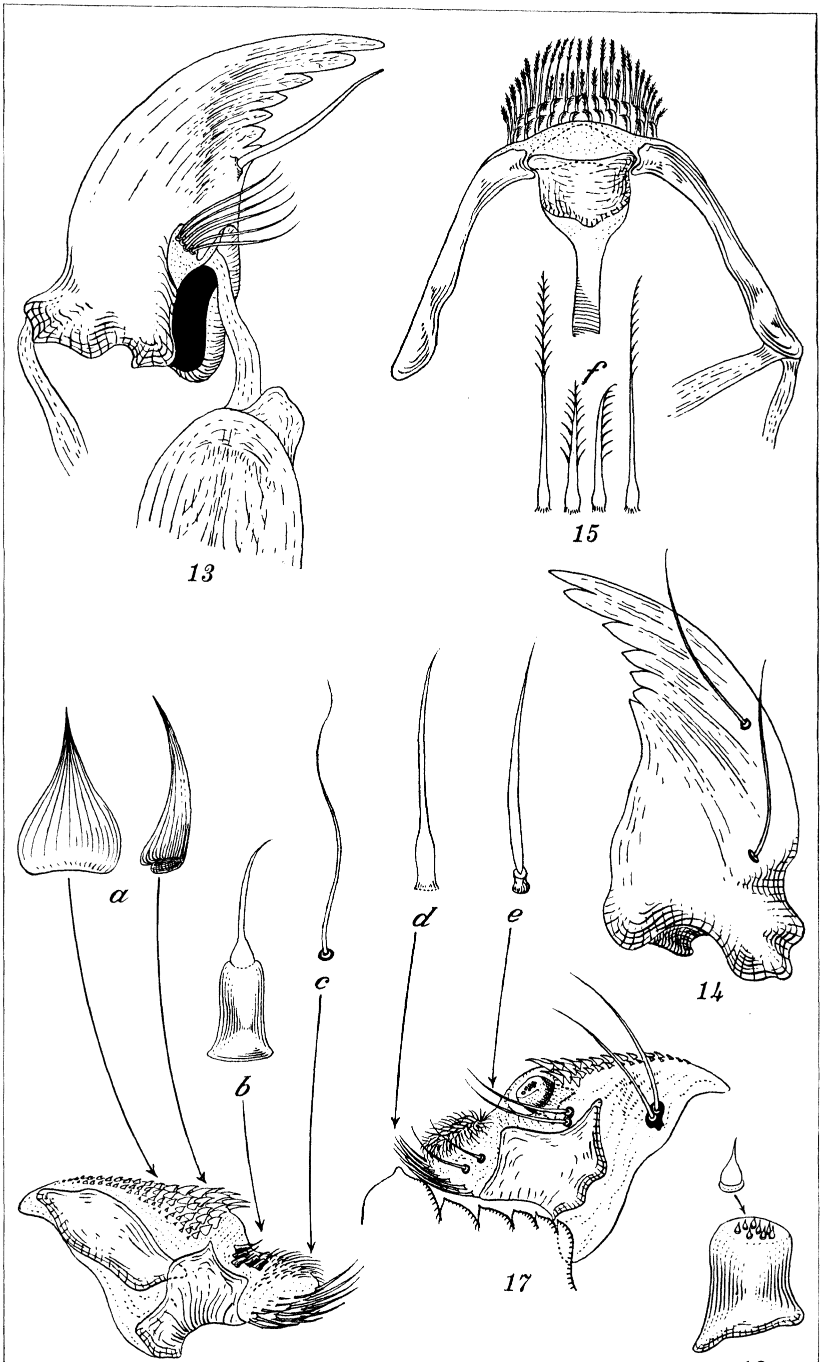


PLATE 3.

ERRATA

VOLUME 56

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Page 225, in the thirteenth line, *for Montillai read Montillae.*

Page 227, under "Plate 3," *for Parapercis montillai* sp. nov. *read Parapercis montillae* sp. nov.

Sequence of plates: *For* Plate 2 *read* Plate 3, *for* Plate 3 *read* Plate 2.

VOLUME 57

Pages 326 and 327, all figures are expressed in percentages.

Volume 57

Page 326, column 1, under CaO, on wet basis, ***for*** 1.96 ***read*** 0.96.

INDEX

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A

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